Effect of Rosy Field and Polarity

Rajendran Raja

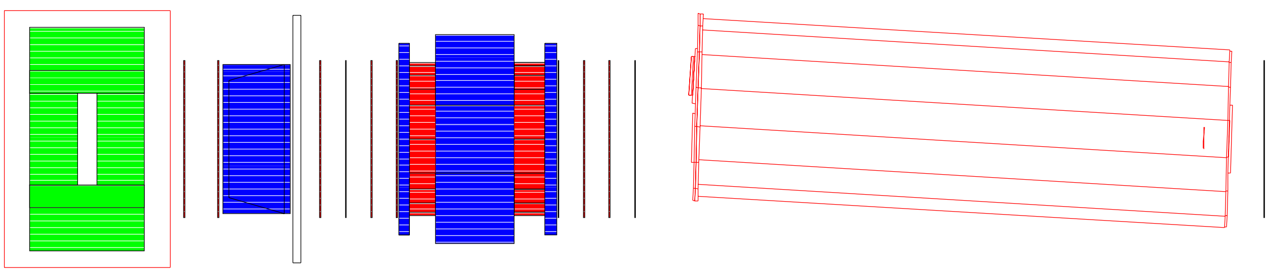
11-Aug-01

Geometry used:-

The following table gives the positions of the detectors in E907mc Monte carlo used for this simulation. The mother volume is called CAVE and is a tube. All positions are with respect to the center of this tube in Centimeters. The co-ordinate system employed is z axis along tube axis along the beam direction , y axis is vertical and x axis is horizontal forming a right handed co-ordinate system.

Object	Z position (cm)
Target	-843.5
Jolly Green Giant	-739.98
Rosy	12.998 vertical aperture=36" default
RICH	947.7
Chamber 1	-552.9
Chamber 2	-487.3
Chamber 3	-290.5
Chamber 4	-241.3
Chamber 5	-192.1
Chamber 6	-142.9
Chamber 7	168.7
Chamber 8	217.9
Chamber 9	267.1
Chamber 10	316.3
Chamber 11	1529.9
Chamber 12	1579.1

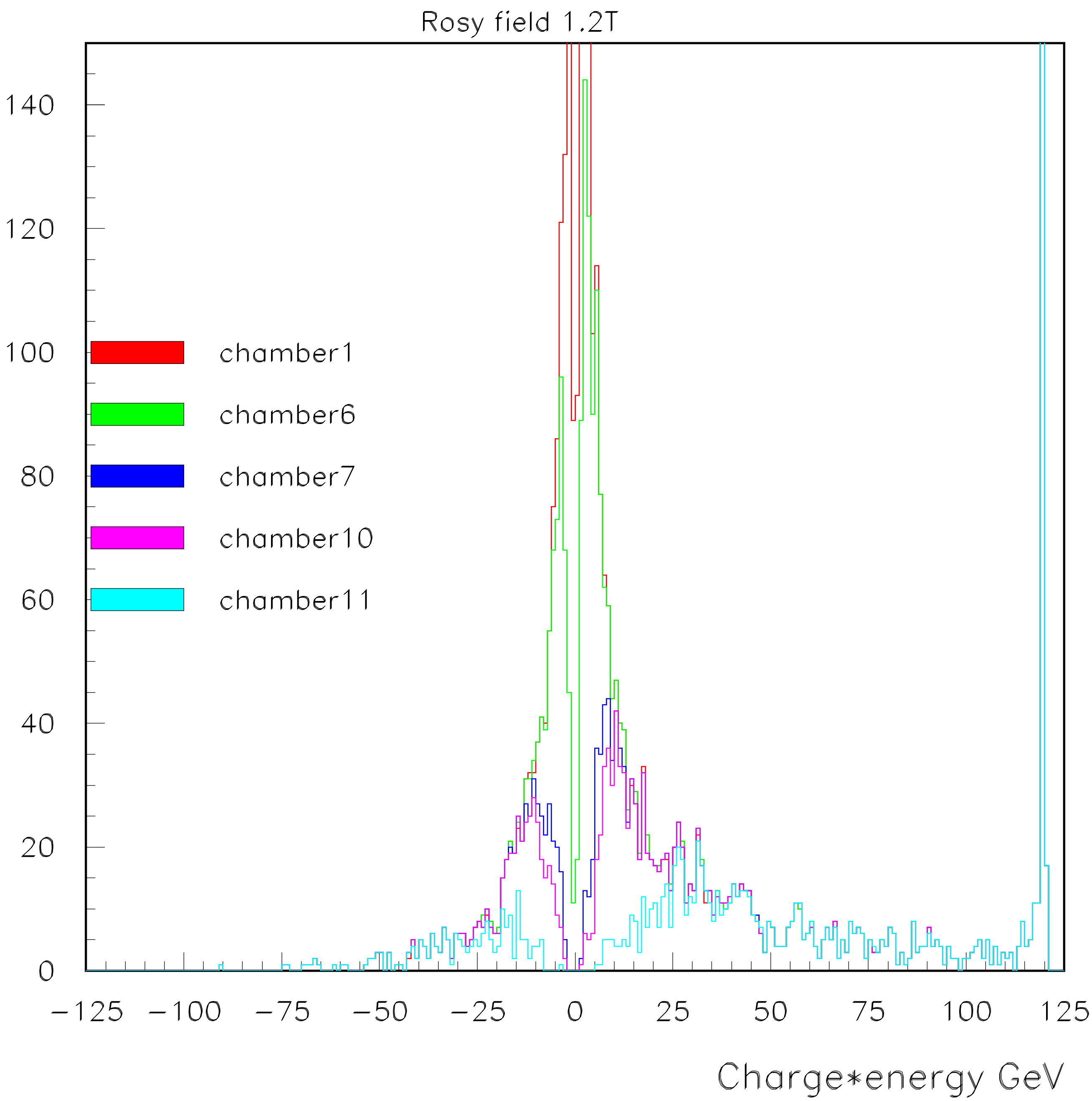
The following picture shows the experiment cut along a vertical plane passing through x=0



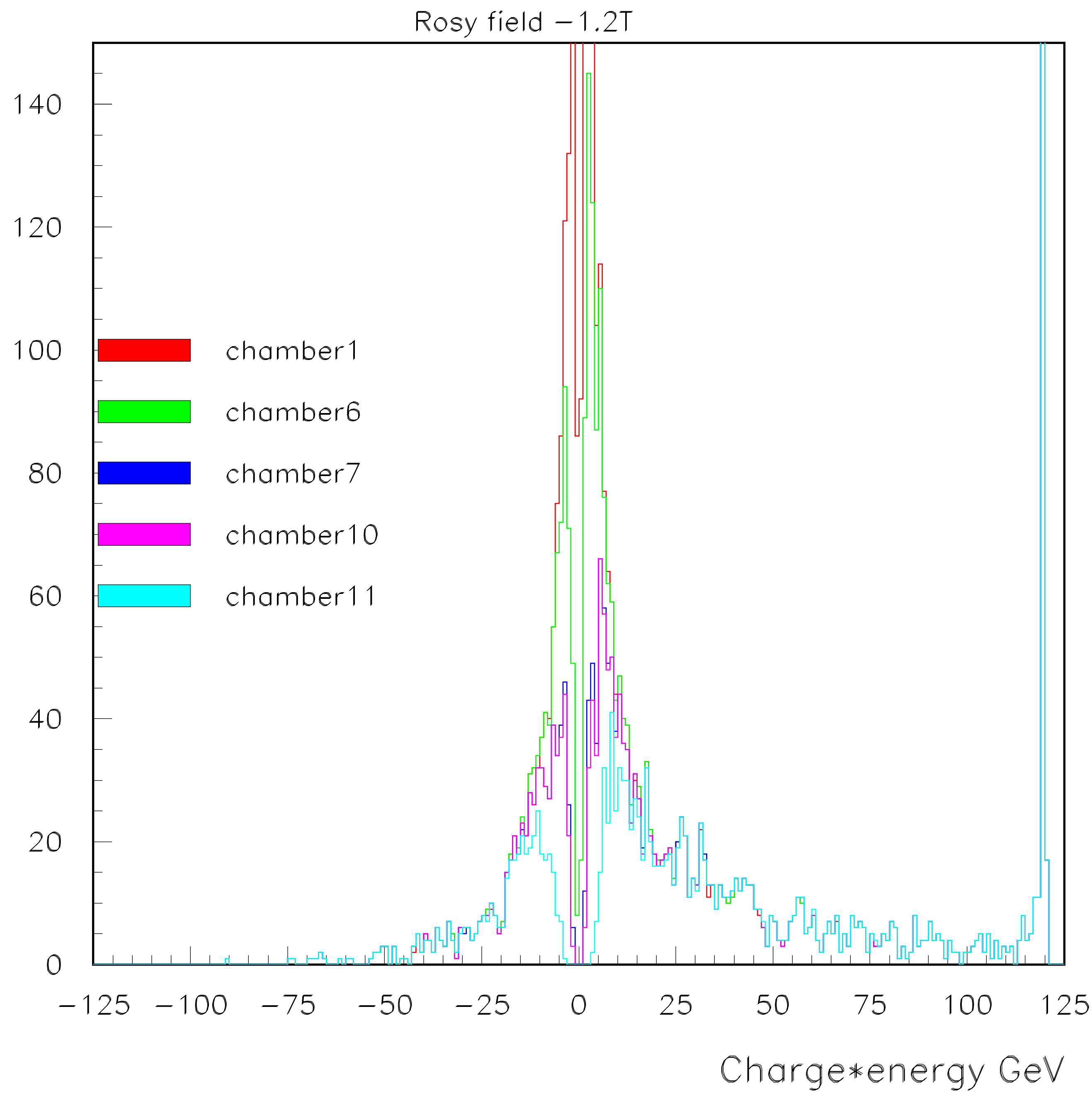
The following set of pictures show the charged particle spectra for 120 GeV pp interactions (PYTHIA, 1000 events)
At chamber 1 (just downstream of Jolly Green Giant), chamber 6(just upstream of ROSY), chamber 7(just downstream of ROSY) chamber 10(just upstream of RICH) and Chamber 11 (downstream of RICH). The ROSY field is assumed to be constant over its volume (we are awaiting an 8 coil field map) to be either 1.2 T or 0.6 T of either polarity. The aim of this study is to determine the relative polarity and strength of the ROSY field with respect to the Jolly Green Giant field which is taken to be 0.7194 Tesla at its maximum point. The field map is taken from E910.

What is plotted are the particle energies (GeV) times the charge so that negative particles will appear with negative energies. For each field configuration, the spectra are plotted at the above mentioned chambers. It can be seen that there is a progressive loss of low energy particles as one proceeds downstream, as one would expect from the action due to the magnets.

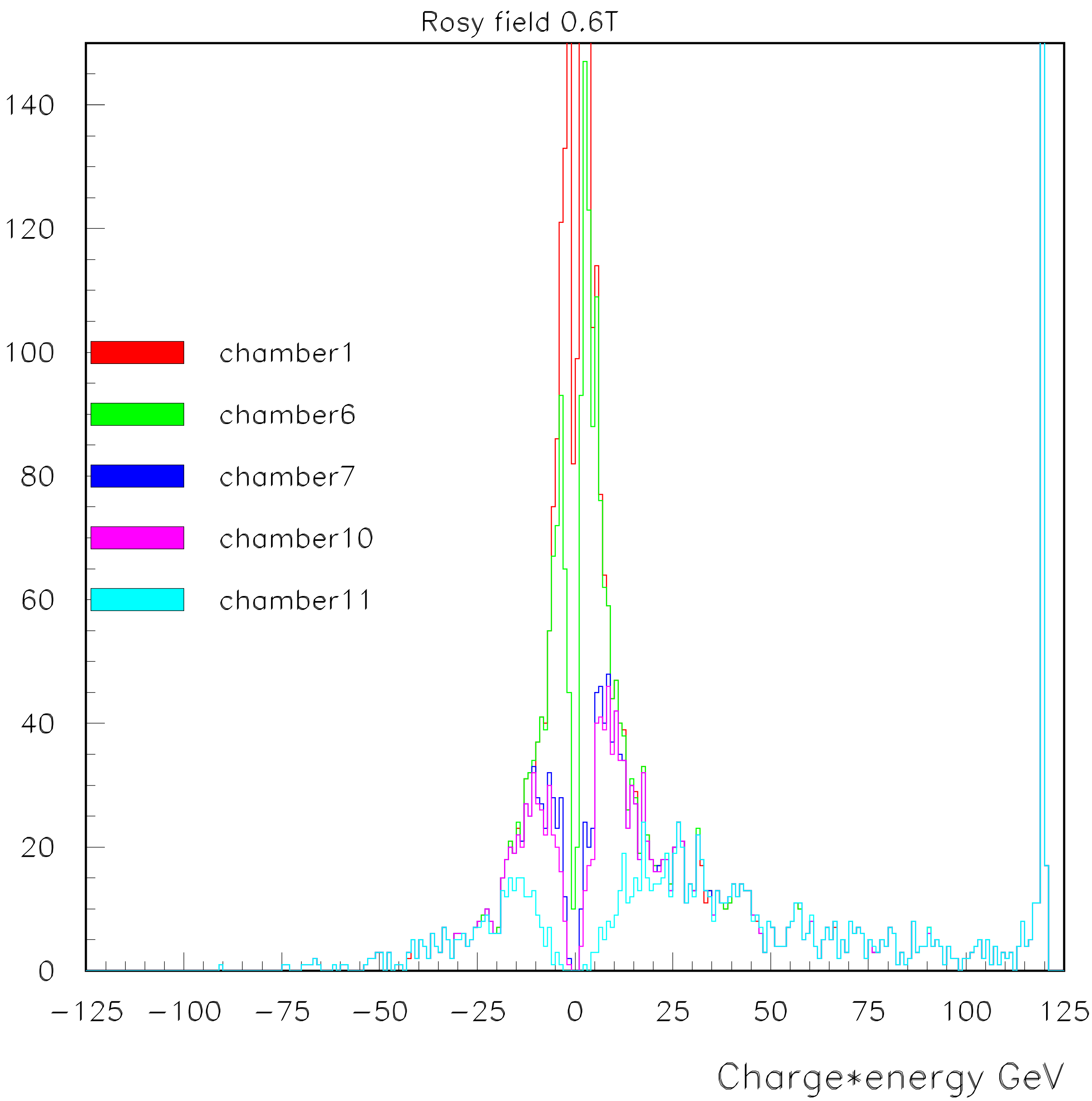
2001/08/11 23.13



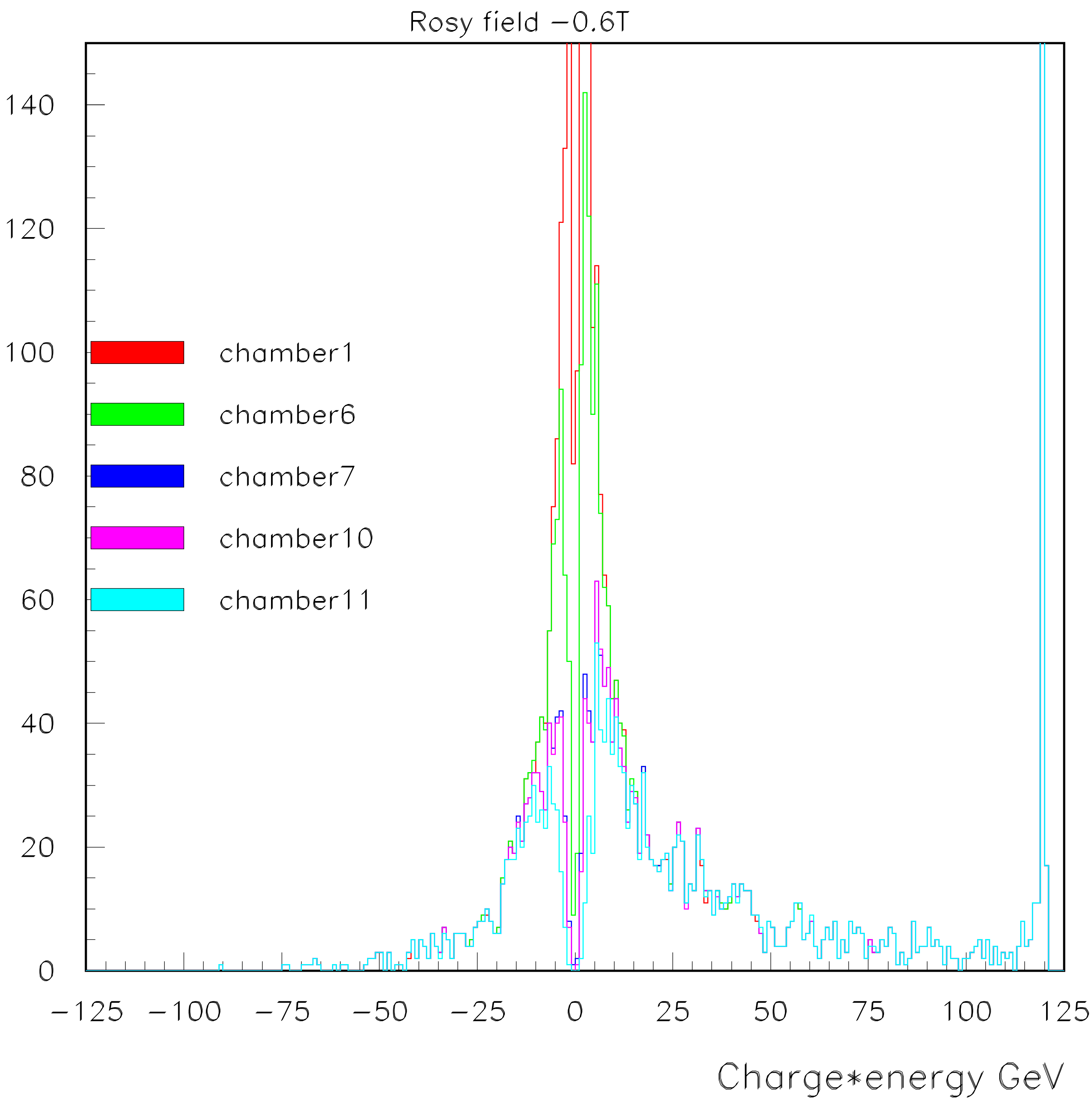
2001/08/11   23.13



2001/08/11 23.13



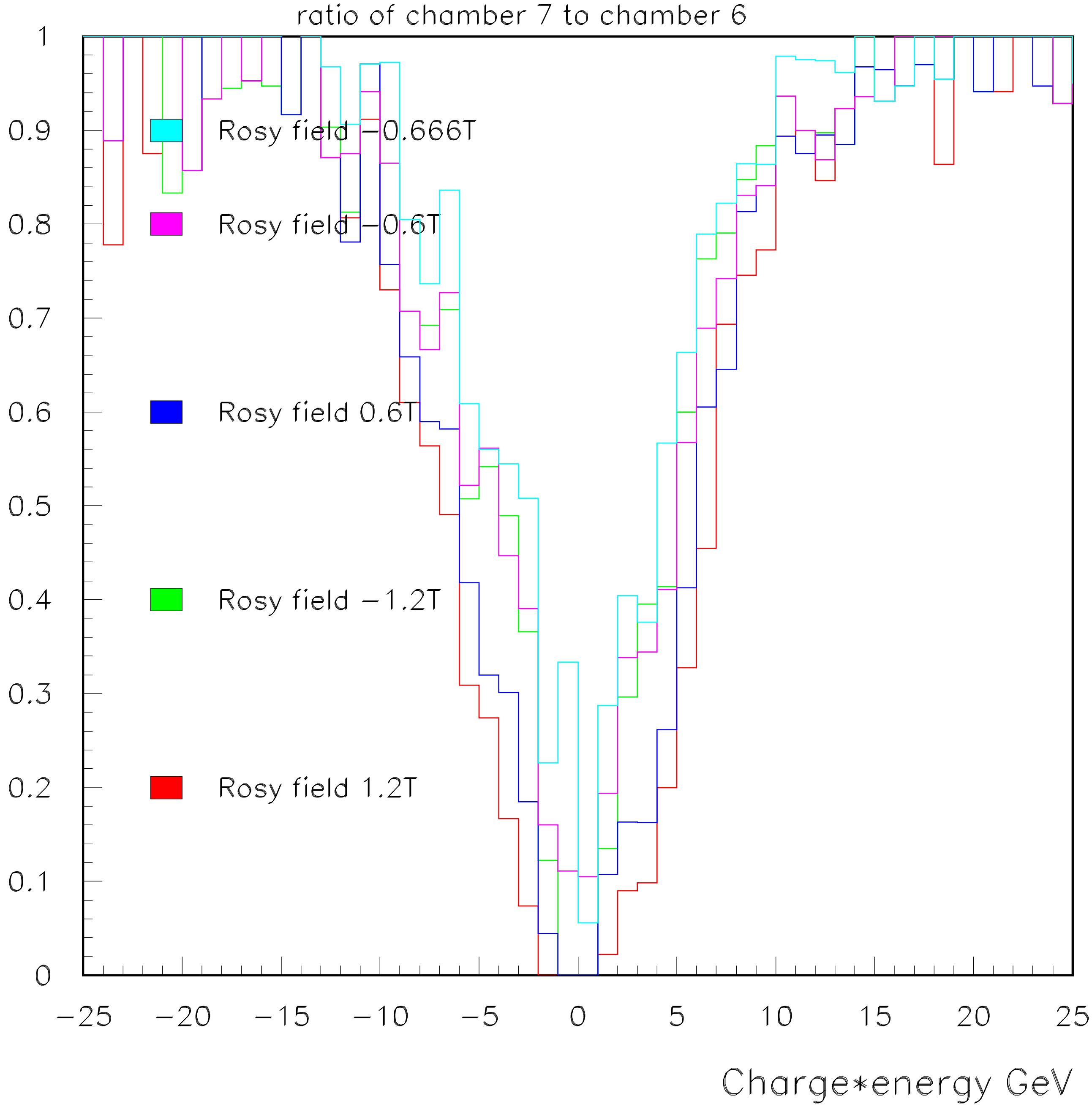
2001/08/11 23.13

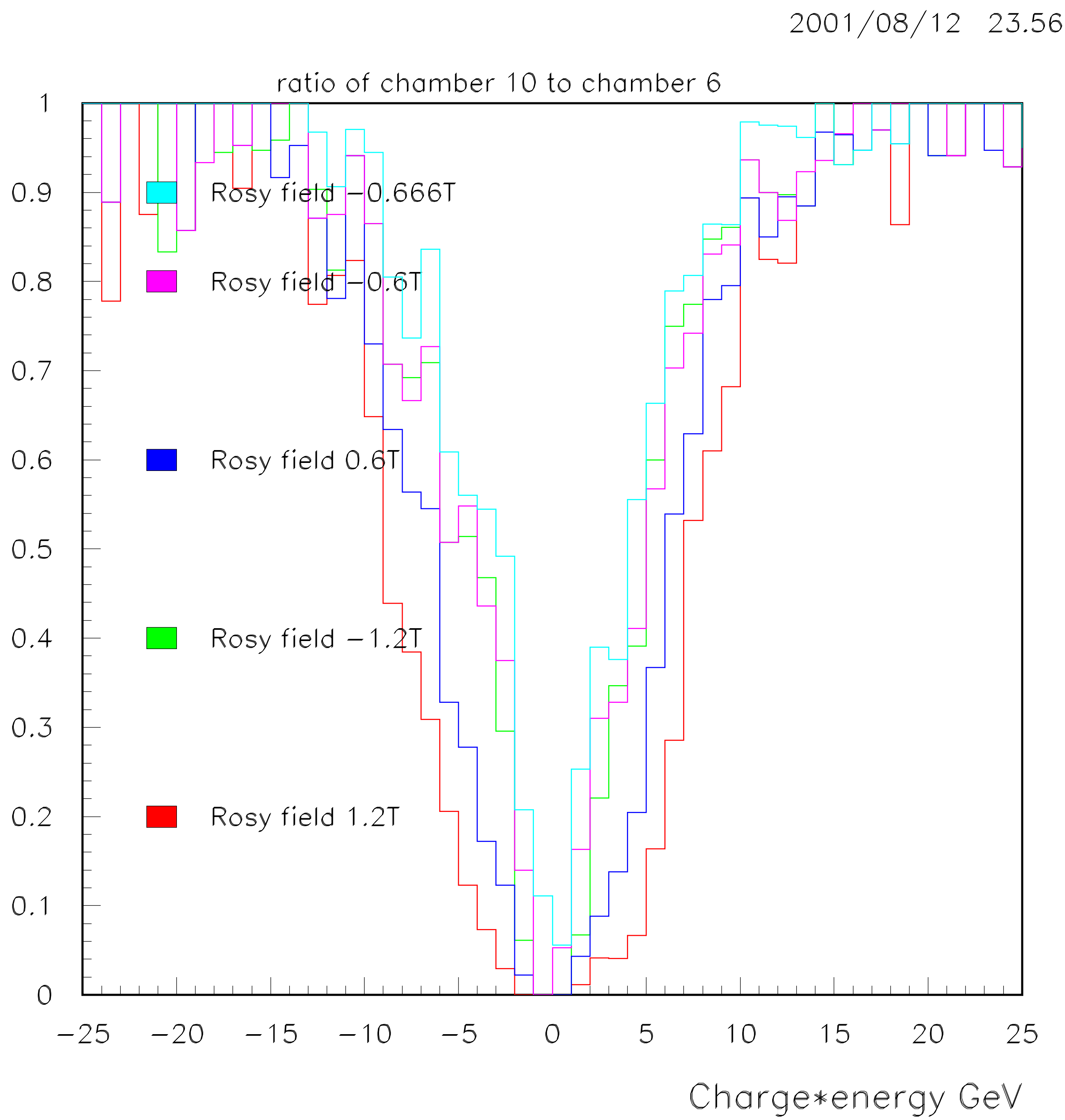


As can be seen from the above pictures, the acceptance at the RICH improves if one runs the magnets at opposite polarity, since the low energy particle (~7.5GeV) will get swept back towards the RICH in this case. We further illustrate this effect by looking at Spectra at chambers as a function of the field. It can be seen that the spectra at chamber 7, just downstream of ROSY are largest for ROSY field of –0.6T (-1.2 T seems to overcorrect Jolly Green Giant). The effect is more pronounce for chamber 10 (upstream of RICH) and chamber 11 (downstream of RICH).

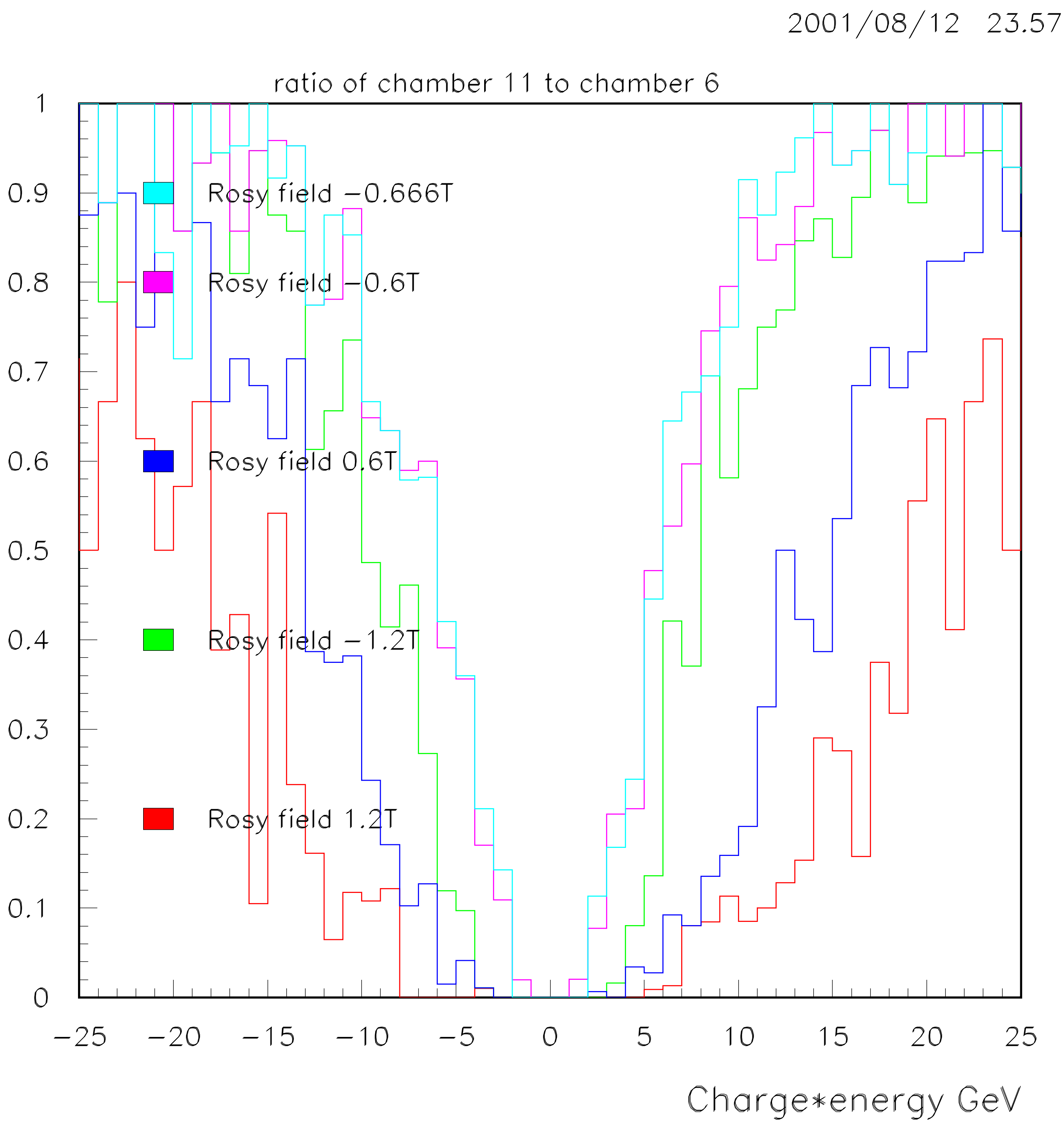
We now plot the ratio of spectra at chambers 7,10 and 11 to that in chamber 6. Chamber 6 is upstream of ROSY and so is unaffected by ROSY currents. Again it is evident that a current of –0.6T in ROSY maximizes the acceptance of low momentum particles (~7.5GeV) at the RICH. 7.5 GeV is the lower end of the RICH acceptance. +1.2T gives the worst acceptance. In order to investigate the dependence of the ROSY vertical aperture, we have re-run the –0.6T point with a vertically widened ROSY with 30cm more aperture. This curve we tag as –0.666T (Sorry guys, this is a preliminary writeup). It can be seen that the vertical aperture is NOT what is causing the loss of particles, it is the momentum kick by ROSY.

2001/08/12 23.56

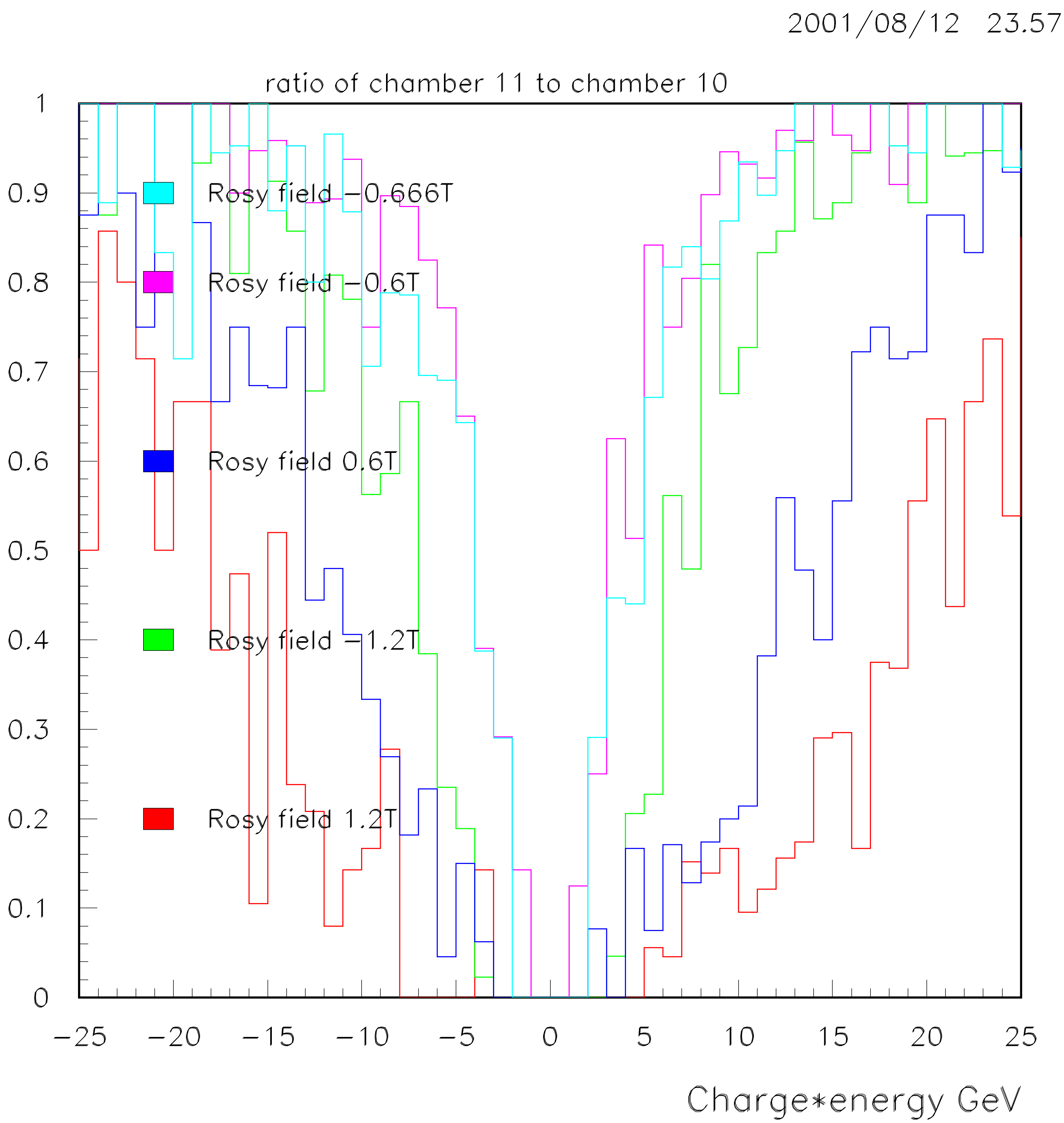




2001/08/12 23.56
ratio of chamber 10 to chamber 6
Rosy field −0.666T
Rosy field −0.6T
Rosy field 0.6T
Rosy field −1.2T
Rosy field 1.2T
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
−25
−20
−15
−10
−5
0
5
10
15
20
25
Charge*energy GeV


2001/08/12 23.57
ratio of chamber 11 to chamber 6
Rosy field −0.666T
Rosy field −0.6T
Rosy field 0.6T
Rosy field −1.2T
Rosy field 1.2T
Charge*energy GeV

Finally we plot the ratio of spectra in chamber 11 (downstream of RICH) to chamber (10) just upstream of RICH. This gives the efficiency of a particle making it through the full length of the RICH. Again –0.6T is seen to be the best among the 4 fields considered. It now remains to be investigated as to what the flip in field strength does to the momentum resolution. That study will also reveal the chamber apertures. What then remains is to vary the positions of the elements to optimize acceptances and resolutions. This will undoubtedly involve bringing the elements closer to each other and shortening the apparatus. What we have just completed is a preliminary look at the magnitude of the effects.


2001/08/12 23.57
ratio of chamber 11 to chamber 10
Rosy field −0.666T
Rosy field −0.6T
Rosy field 0.6T
Rosy field −1.2T
Rosy field 1.2T
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
−25
−20
−15
−10
−5
0
5
10
15
20
25
Charge*energy GeV

E907 Momentum Resolution Study

Rajendran Raja

3-Sep-01

Method:-We have generated 1000 120GeV/c pp events using Pythia. For each track, two other tracks were generated the first with 1.1 times the track momentum and the other with 0.9 times the track momentum. These two tracks were used to find two values of the derivative dx_i/dp at each chamber, where x_i is the x co-ordinate in the i^{th} chamber, and p the momentum of the parent track. The two values of dx_i/dp were averaged together to get the central dx_i/dp at the track. If we assume that all other track quantities are known and we are only determining the momentum resolution of the track, then the error matrix formula simplifies to

$$1/\sigma_p^2 = \Sigma_i (dx_i/dp)^2/\sigma_i^2$$

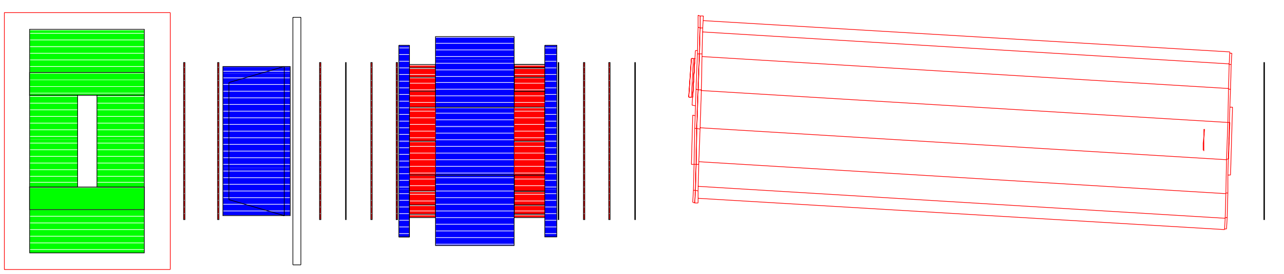
This enables one to determine the fractional momentum resolution σ_p /p as a function of momentum track by track. Multiple scattering is included, since Geant generates tracks in the presence of all interactions. (The special cases where the the two "differential tracks" tracks behave differently from the parent track due to Geant interactions and decay need careful treatment and has taken a significant amount of time.). The chamber resolutions σ_i are all taken to be 200 microns for this study. The momentum resolution thus obtained is clearly too optimistic, since it does not include the effects of the errors in the direction of the tracks. But this gives us an excellent way of studying the effect of chamber placement without smearing and fitting.

The chamber positions are given in the following table and illustrated in the following figure, which we include for completeness.

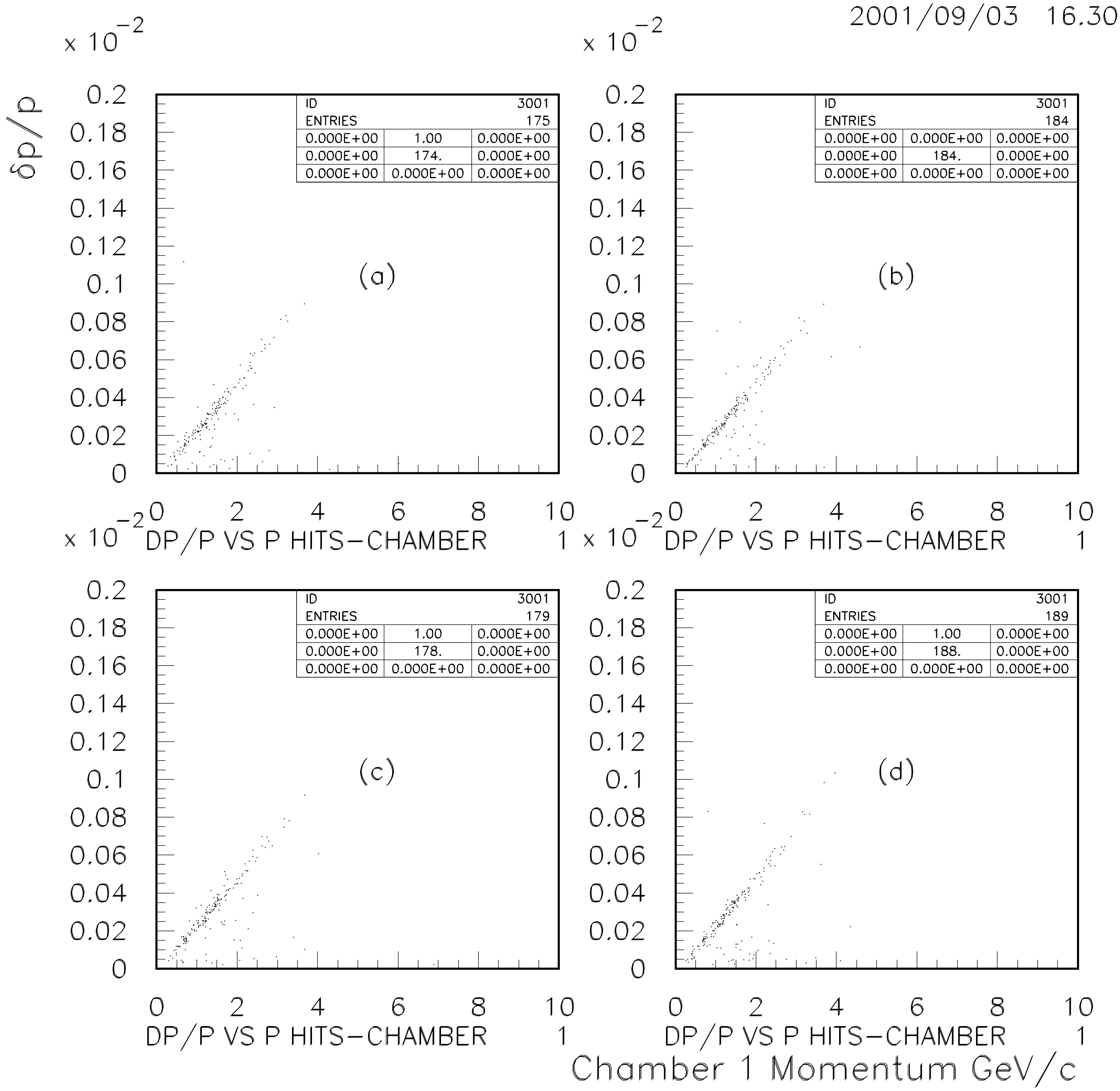
```
Geometry used:
The following table gives the positions of the detectors in E907
this simulation. The mother volume is called CAVE and is a tube.
respect to the center of this tube in centimeters. The coordinate system employed i
axis along tube axis along the beam direction , y axis is vertic
forming a right handed coordinate system.
```

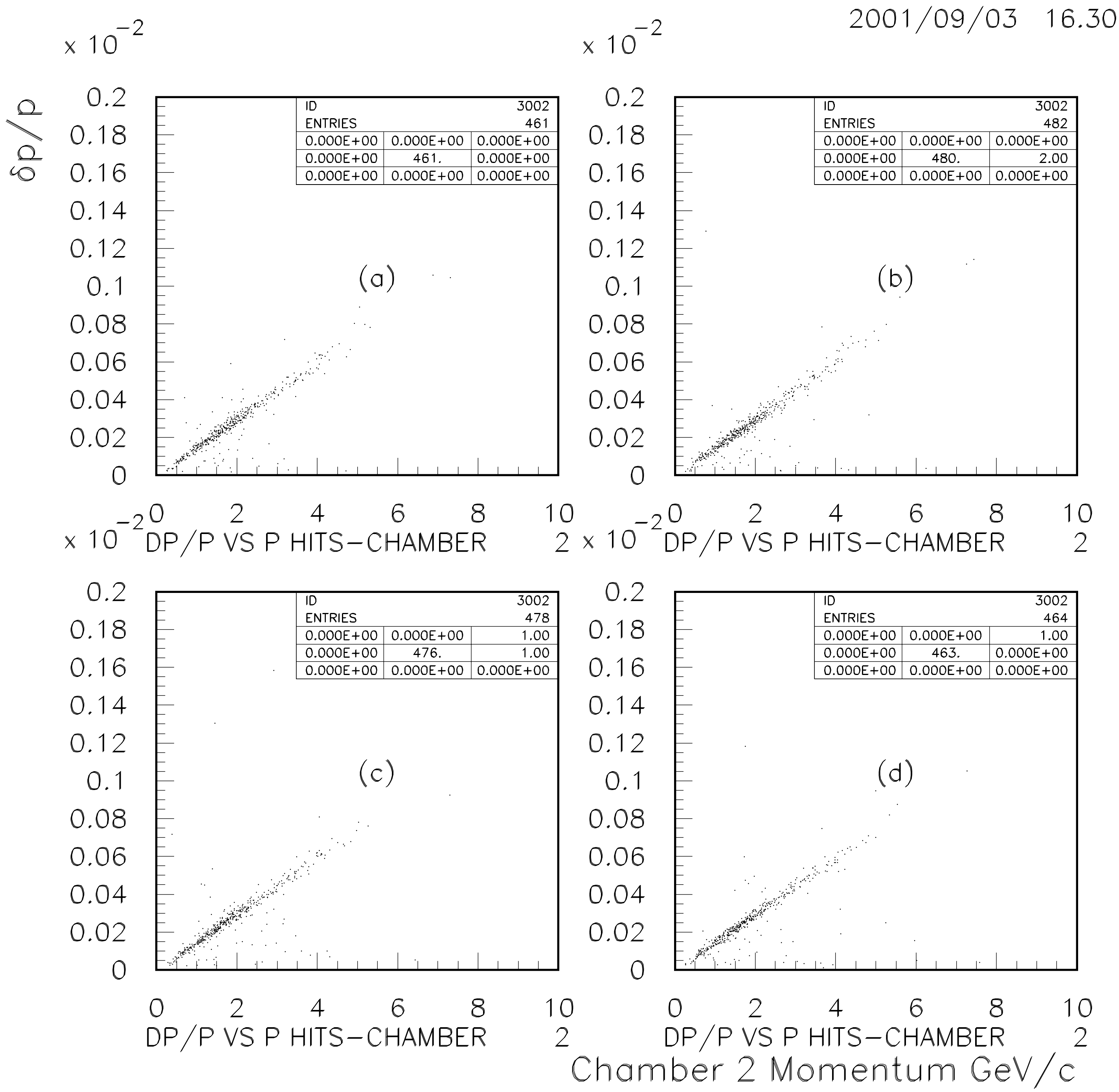
Object	Z position (cm)
Target	-843.5
Jolly Green Giant	-739.98
Rosy	12.998 vertical aperture=36" def
RICH	947.7
Chamber 1	-552.9
Chamber 2	-487.3
Chamber 3	-290.5
Chamber 4	-241.3
Chamber 5	-192.1
Chamber 6	-142.9
Chamber 7	168.7
Chamber 8	217.9
Chamber 9	267.1
Chamber 10	316.3
Chamber 11	1529.9
Chamber 12	1579.1

```
The following picture shows the experiment cut along a vertical
x=0
```

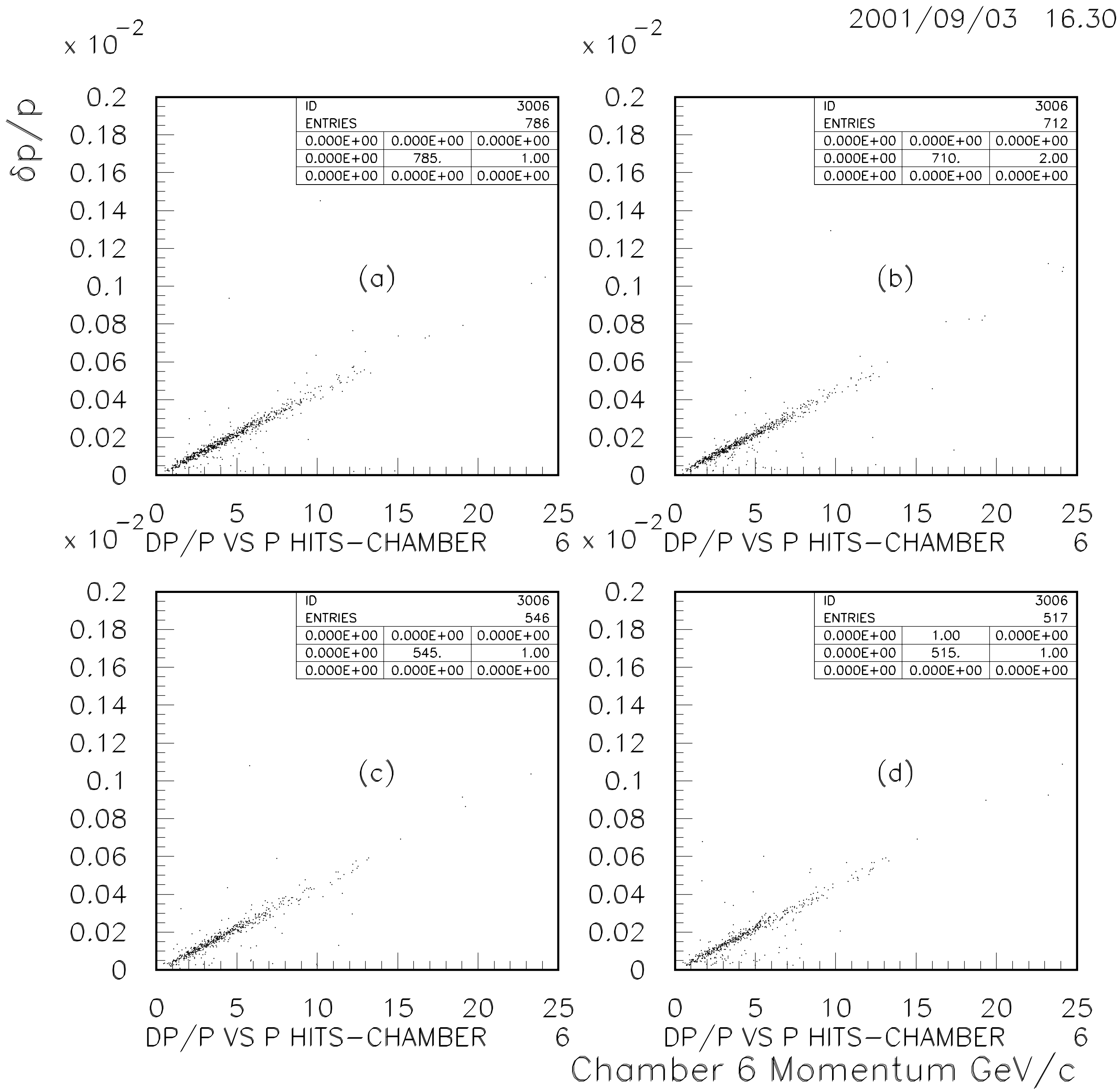


The following figures contain the fractional momentum resolution as a function of momentum for the 12 chambers. A track is plotted as being associated with a particular chamber if that is the last chamber hit by the track. The figures marked (a) are for ROSY field +1.2 Tesla, (b) for +0.6Tesla (c) for –0.6Tesla and (d) for –1.2Tesla. Clearly no difference is expected between the cases (a), (b),(c) and (d) for chambers upstream of ROSY, that is Chambers 1-6. It can be seen that the fractional resolution improves as more chambers come into play. TPC hits are included in all these plots. TPC is treated as 128 chambers in exactly the same way as the other chambers. The vertex z position of all tracks is constrained to smaller than –840cm to avoid particles that start in the middle of the TPC from strange particle decays.

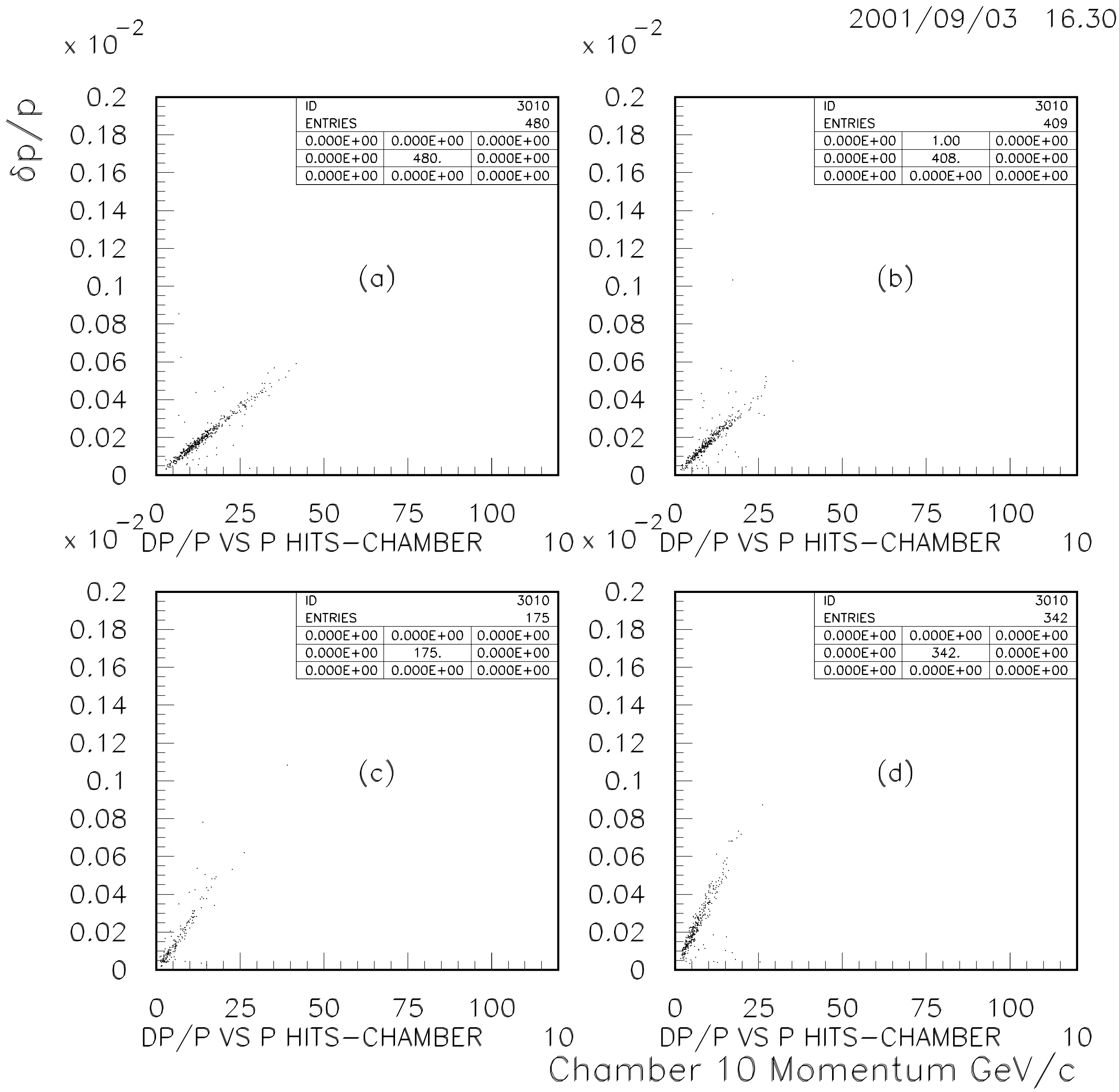

2001/09/03 16.30
x 10^-2
δp/p
ID 3001
ENTRIES 175
0.000E+00 1.00 0.000E+00
0.000E+00 174. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
ID 3001
ENTRIES 184
0.000E+00 0.000E+00 0.000E+00
0.000E+00 184. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(b)
ID 3001
ENTRIES 179
0.000E+00 1.00 0.000E+00
0.000E+00 178. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(c)
ID 3001
ENTRIES 189
0.000E+00 1.00 0.000E+00
0.000E+00 188. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(d)
0 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18 0.2
0 2 4 6 8 10
DP/P VS P HITS-CHAMBER 1
Chamber 1 Momentum GeV/c

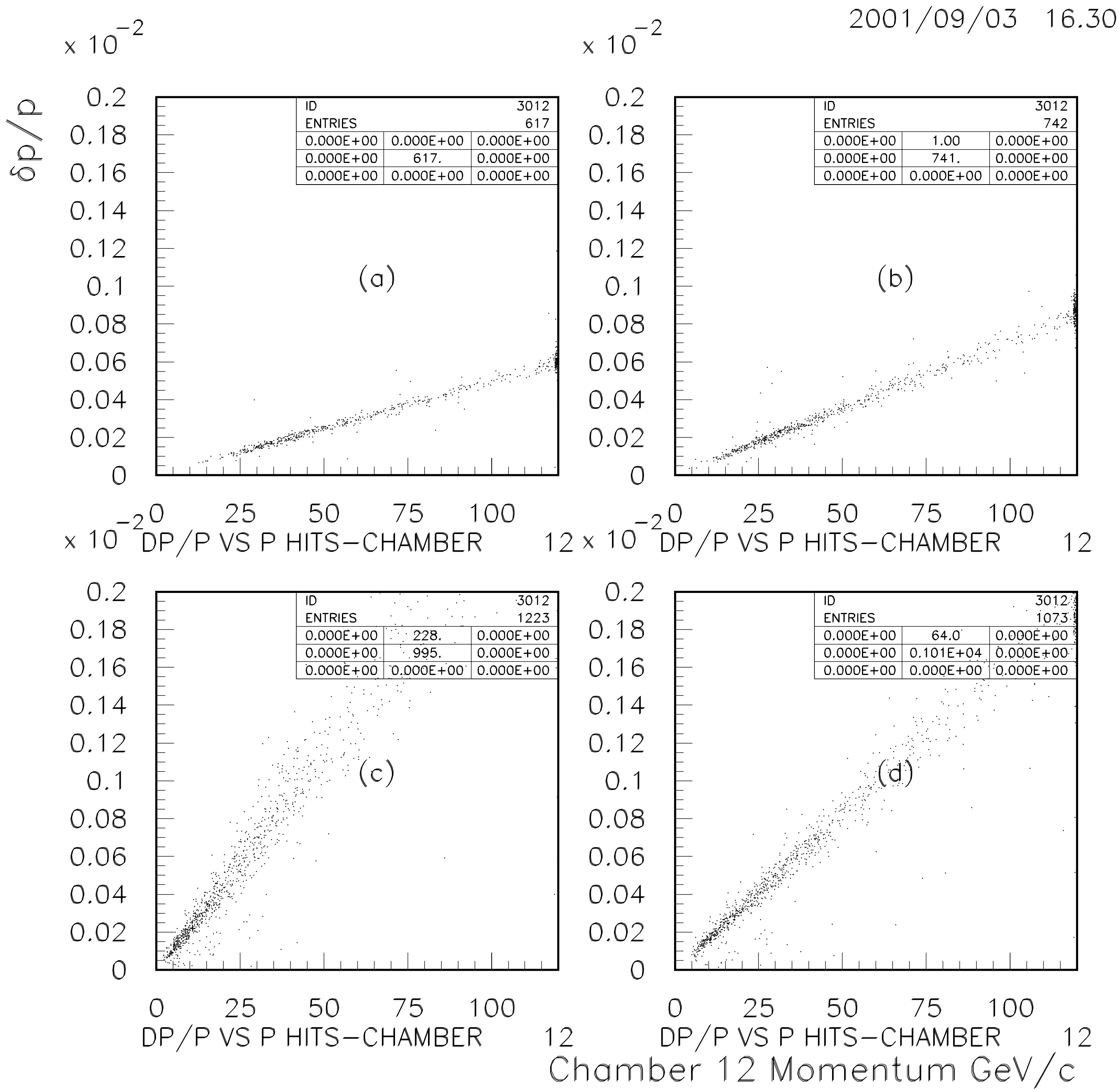


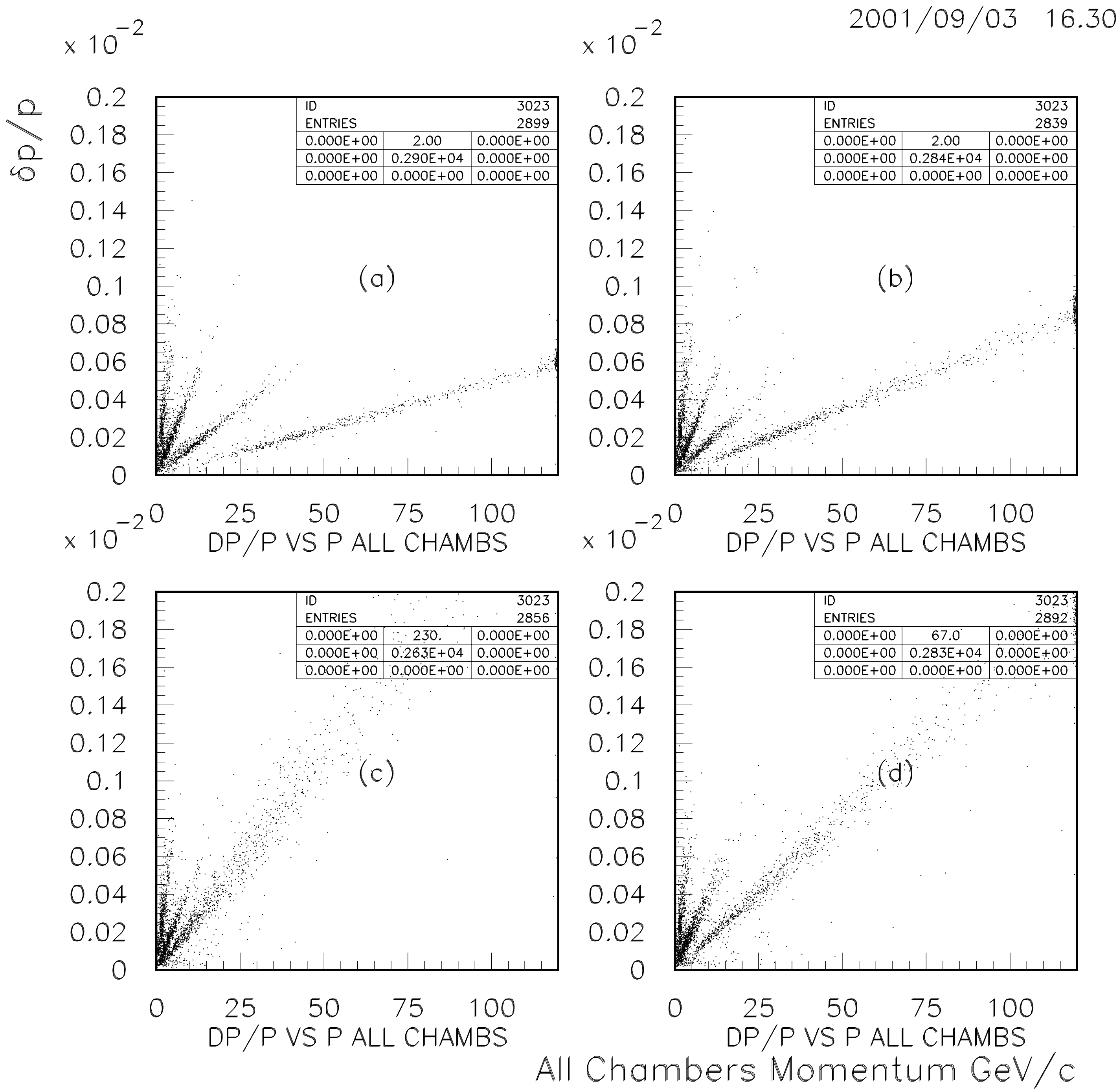
2001/09/03 16.30
x 10^-2
δp/p
ID 3002
ENTRIES 461
0.000E+00 0.000E+00 0.000E+00
0.000E+00 461. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
DP/P VS P HITS-CHAMBER 2
ID 3002
ENTRIES 482
0.000E+00 0.000E+00 0.000E+00
0.000E+00 480. 2.00
0.000E+00 0.000E+00 0.000E+00
(b)
DP/P VS P HITS-CHAMBER 2
ID 3002
ENTRIES 478
0.000E+00 0.000E+00 1.00
0.000E+00 476. 1.00
0.000E+00 0.000E+00 0.000E+00
(c)
DP/P VS P HITS-CHAMBER 2
ID 3002
ENTRIES 464
0.000E+00 0.000E+00 1.00
0.000E+00 463. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(d)
DP/P VS P HITS-CHAMBER 2
Chamber 2 Momentum GeV/c

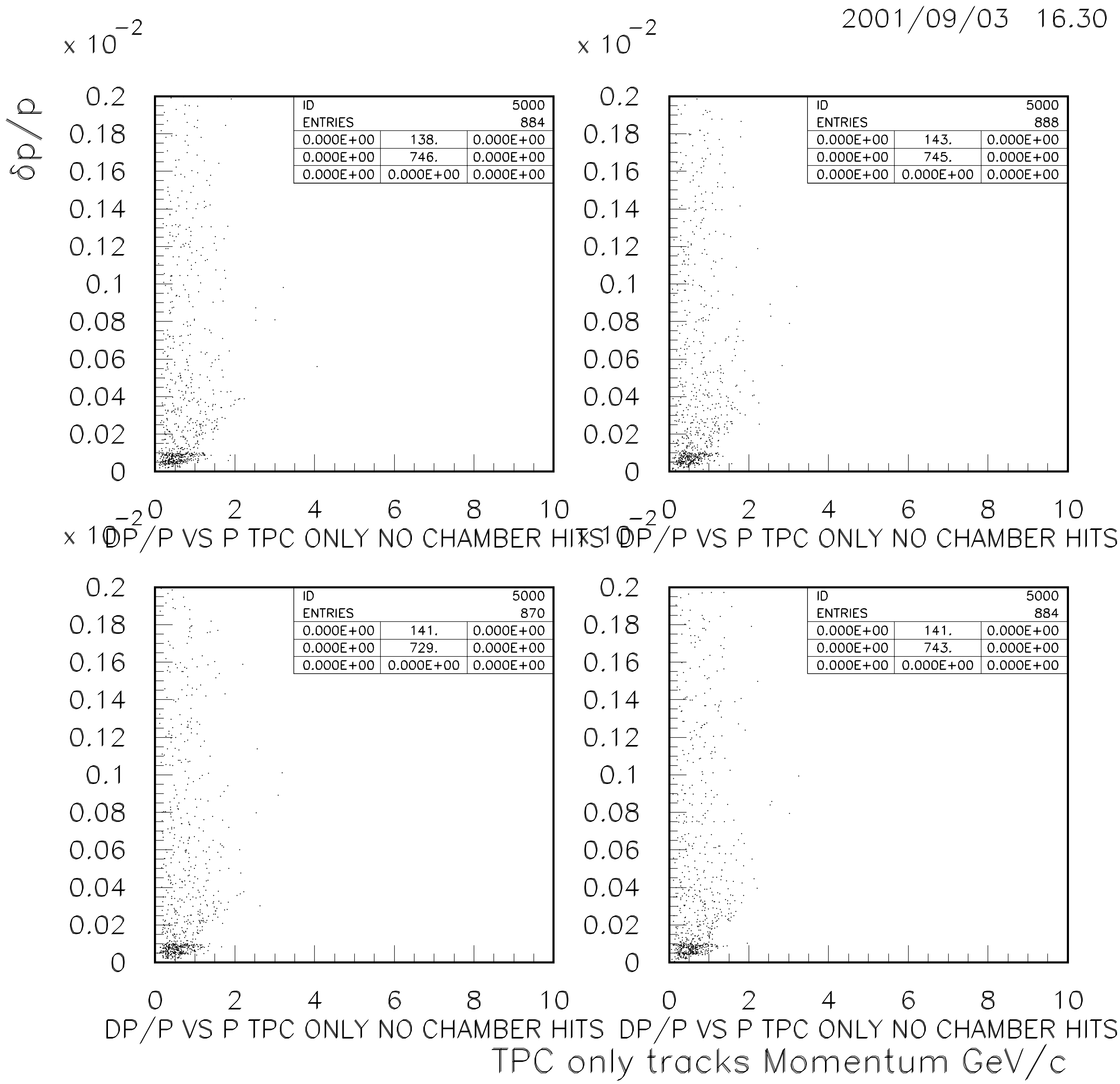


2001/09/03 16.30
δp/p
x 10^-2
ID 3006
ENTRIES 786
0.000E+00 0.000E+00 0.000E+00
0.000E+00 785. 1.00
0.000E+00 0.000E+00 0.000E+00
(a)
DP/P VS P HITS-CHAMBER 6
ID 3006
ENTRIES 712
0.000E+00 0.000E+00 0.000E+00
0.000E+00 710. 2.00
0.000E+00 0.000E+00 0.000E+00
(b)
DP/P VS P HITS-CHAMBER 6
ID 3006
ENTRIES 546
0.000E+00 0.000E+00 0.000E+00
0.000E+00 545. 1.00
0.000E+00 0.000E+00 0.000E+00
(c)
DP/P VS P HITS-CHAMBER 6
ID 3006
ENTRIES 517
0.000E+00 1.00 0.000E+00
0.000E+00 515. 1.00
0.000E+00 0.000E+00 0.000E+00
(d)
DP/P VS P HITS-CHAMBER 6
Chamber 6 Momentum GeV/c


2001/09/03 16.30
δp/p
x 10^-2
ID 3010
ENTRIES 480
0.000E+00 0.000E+00 0.000E+00
0.000E+00 480. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
DP/P VS P HITS-CHAMBER 10
ID 3010
ENTRIES 409
0.000E+00 1.00 0.000E+00
0.000E+00 408. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(b)
DP/P VS P HITS-CHAMBER 10
ID 3010
ENTRIES 175
0.000E+00 0.000E+00 0.000E+00
0.000E+00 175. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(c)
DP/P VS P HITS-CHAMBER 10
ID 3010
ENTRIES 342
0.000E+00 0.000E+00 0.000E+00
0.000E+00 342. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(d)
DP/P VS P HITS-CHAMBER 10
Chamber 10 Momentum GeV/c


2001/09/03 16.30
δp/p
x 10^-2
ID 3012
ENTRIES 617
0.000E+00 0.000E+00 0.000E+00
0.000E+00 617. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
DP/P VS P HITS−CHAMBER 12
ID 3012
ENTRIES 742
0.000E+00 1.00 0.000E+00
0.000E+00 741. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(b)
DP/P VS P HITS−CHAMBER 12
ID 3012
ENTRIES 1223
0.000E+00 228. 0.000E+00
0.000E+00 995. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(c)
DP/P VS P HITS−CHAMBER 12
ID 3012
ENTRIES 1073
0.000E+00 64.0 0.000E+00
0.000E+00 0.101E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(d)
DP/P VS P HITS−CHAMBER 12
Chamber 12 Momentum GeV/c


2001/09/03 16.30
x 10^-2
δp/p
ID 3023
ENTRIES 2899
0.000E+00 2.00 0.000E+00
0.000E+00 0.290E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(a)
ID 3023
ENTRIES 2839
0.000E+00 2.00 0.000E+00
0.000E+00 0.284E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(b)
DP/P VS P ALL CHAMBS
ID 3023
ENTRIES 2856
0.000E+00 230. 0.000E+00
0.000E+00 0.263E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(c)
ID 3023
ENTRIES 2892
0.000E+00 67.0 0.000E+00
0.000E+00 0.283E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
(d)
All Chambers Momentum GeV/c


2001/09/03 16.30
ID 5000
ENTRIES 884
0.000E+00 138. 0.000E+00
0.000E+00 746. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
ID 5000
ENTRIES 888
0.000E+00 143. 0.000E+00
0.000E+00 745. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
ID 5000
ENTRIES 870
0.000E+00 141. 0.000E+00
0.000E+00 729. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
ID 5000
ENTRIES 884
0.000E+00 141. 0.000E+00
0.000E+00 743. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
δp/p
x 10^-2
DP/P VS P TPC ONLY NO CHAMBER HITS
TPC only tracks Momentum GeV/c

Chamber	Rosy+1.2T	Rosy+0.6T	Rosy-0.6T	Rosy-1.2T
1	1.027E-04	1.065E-04	1.033E-04	1.033E-04
2	9.631E-05	9.537E-05	9.538E-05	9.448E-05
3	5.560E-05	6.071E-05	6.153E-05	6.060E-05
4	5.206E-05	5.346E-05	5.292E-05	5.100E-05
5	4.474E-05	4.610E-05	4.578E-05	4.539E-05
6	4.048E-05	3.994E-05	4.045E-05	3.969E-05
7	2.710E-05	0.000E+01	2.650E-05	3.764E-05
8	2.008E-05	2.337E-05	3.100E-05	3.460E-05
9	1.608E-05	1.907E-05	1.550E-05	2.863E-05
10	1.410E-05	1.721E-05	2.524E-05	3.384E-05
11	6.940E-06	9.260E-06	1.156E-05	1.899E-05
12	5.010E-06	7.241E-06	2.185E-05	1.593E-05

Cutting on Momentum resolution

In order to determine the aperture needed by chambers at particular positions, we employ the following technique. Let us say that a track passes through k chambers before exiting. Then for each chamber i, i=1,k, we associate a quantity called the fractional resolution f_i where f_i is defined as the resolution that would be obtained by all chambers preceding chamber i (including the TPC, but not including i) expressed as a fraction of the resolution obtained by all chambers including the last chamber k.

i.e.

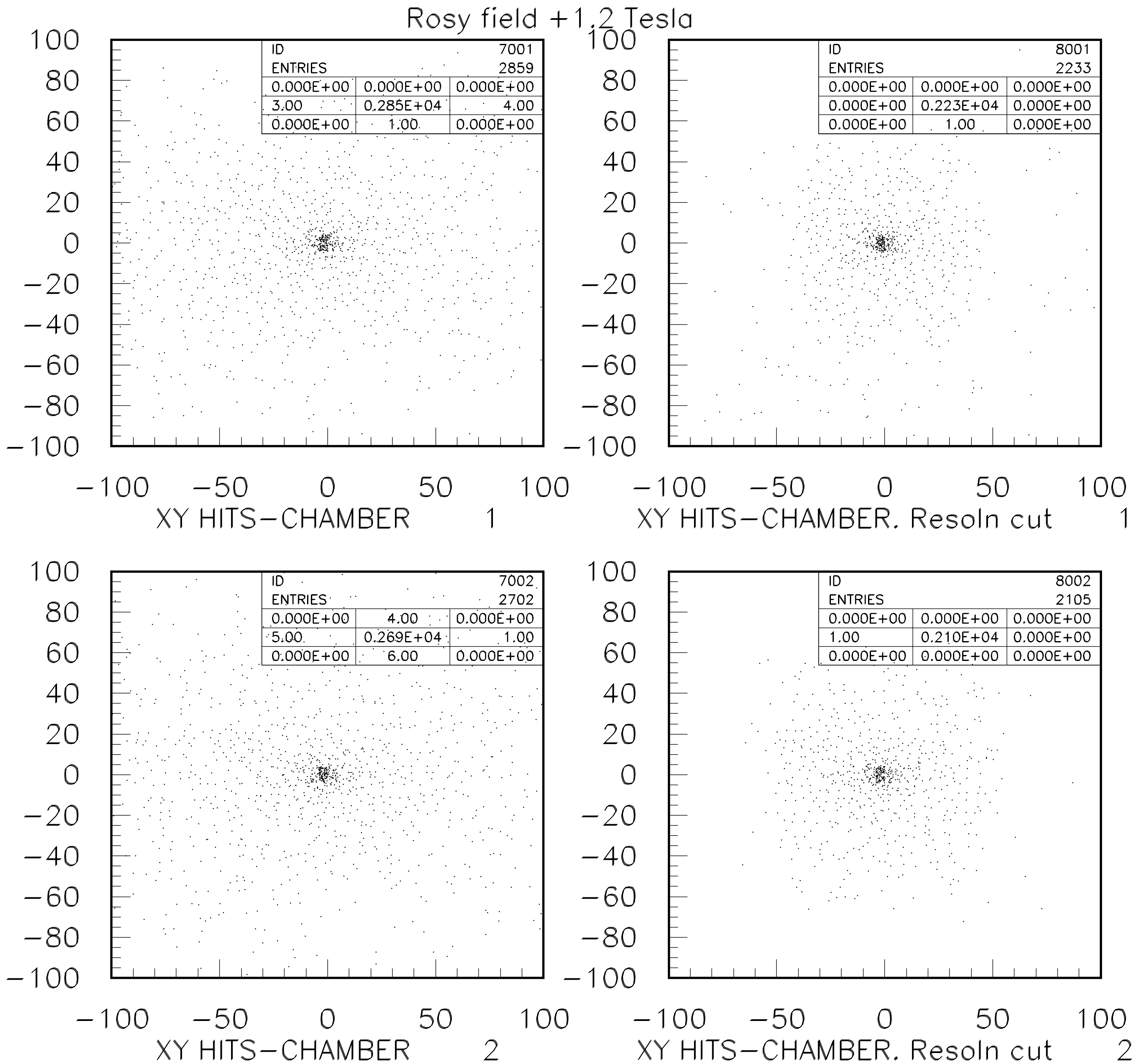
$f_{i} =$ (resolution of track using all chambers 1-k)/(resolution of track using chambers TPC to chamber i-1)

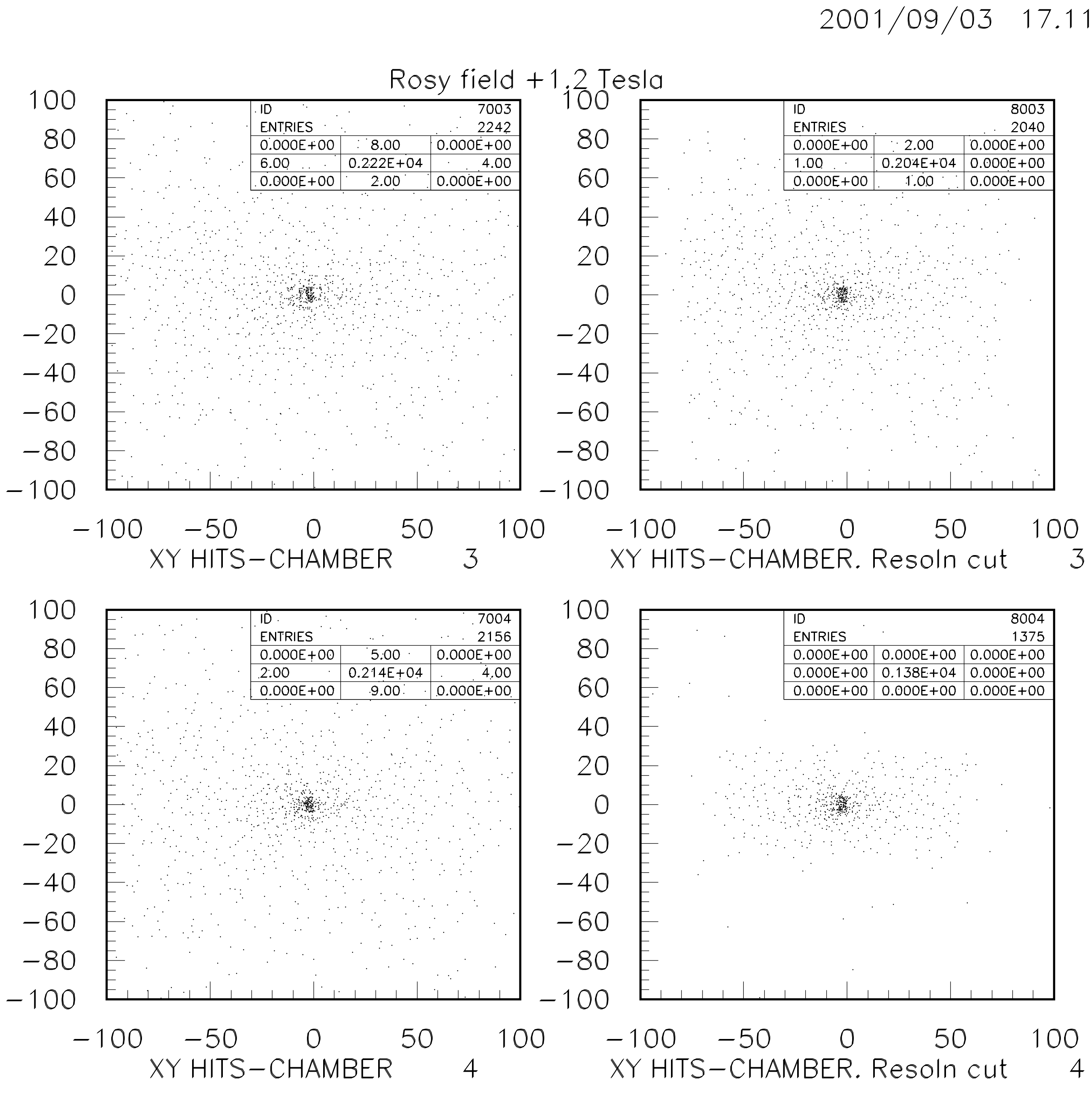
We then plot the x and y position of hits in each chamber for all tracks and compare it with xy plots where the track is not plotted in chamber m if f_m is greater than a cut off (0.5). This means that the m^{th} chamber and the following chambers will add less than 50% more resolution for this track. 50% is a harsh cut and we will want to optimize this further and increase it to say 70% or so. So for each chamber we get two plots. The overall xy distribution and the truncated xy distribution. The truncated xy distribution gives the chamber size at that point.

The following figures give such distributions for all chambers for Rosy fields +1.2T and for chambers 7-12 (downstream of ROSY) for ROSY fields +0.6T, -0.6T and –1.2T.

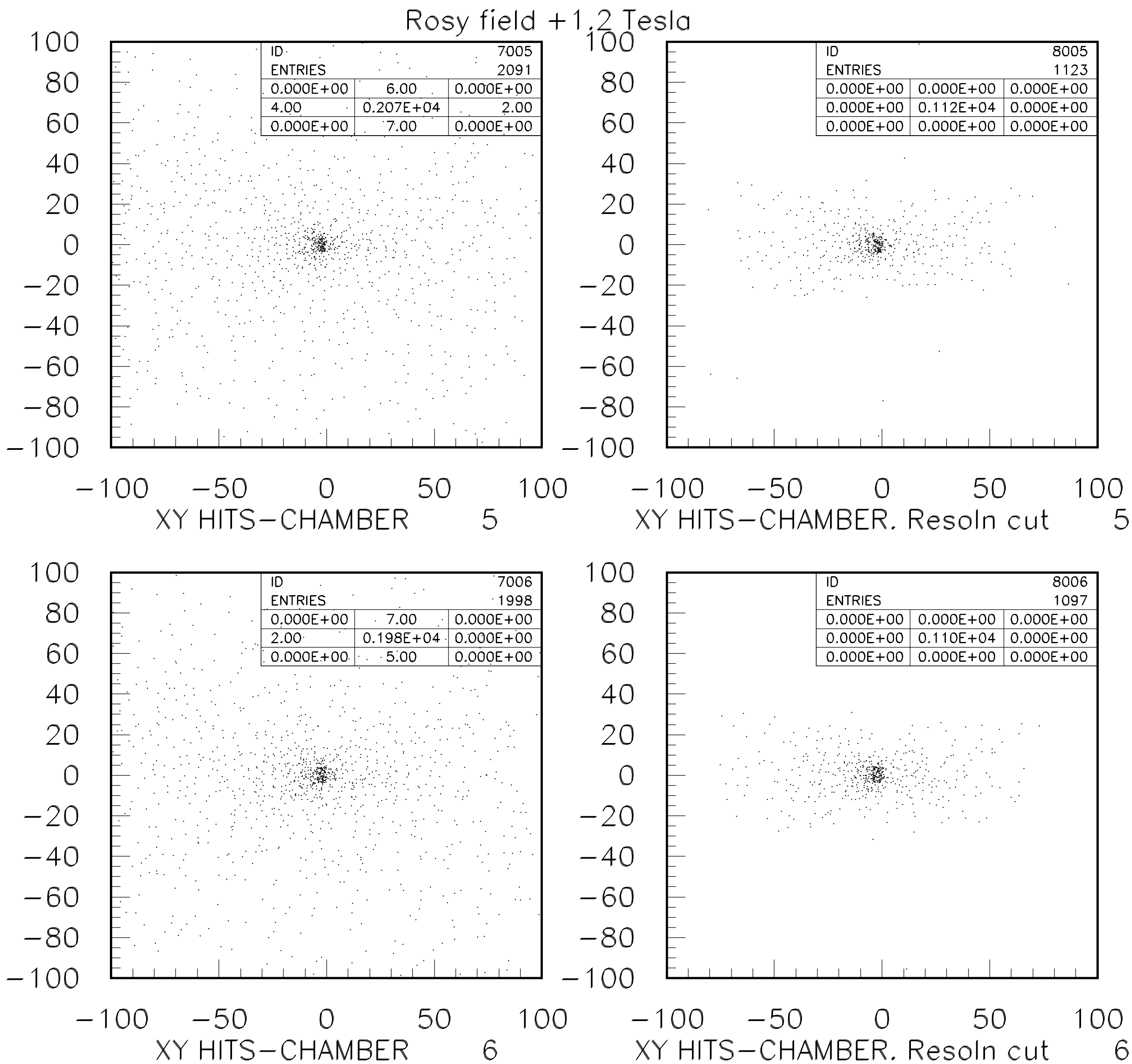
This is followed by a spreadsheet of available chambers.

2001/09/03 17.11

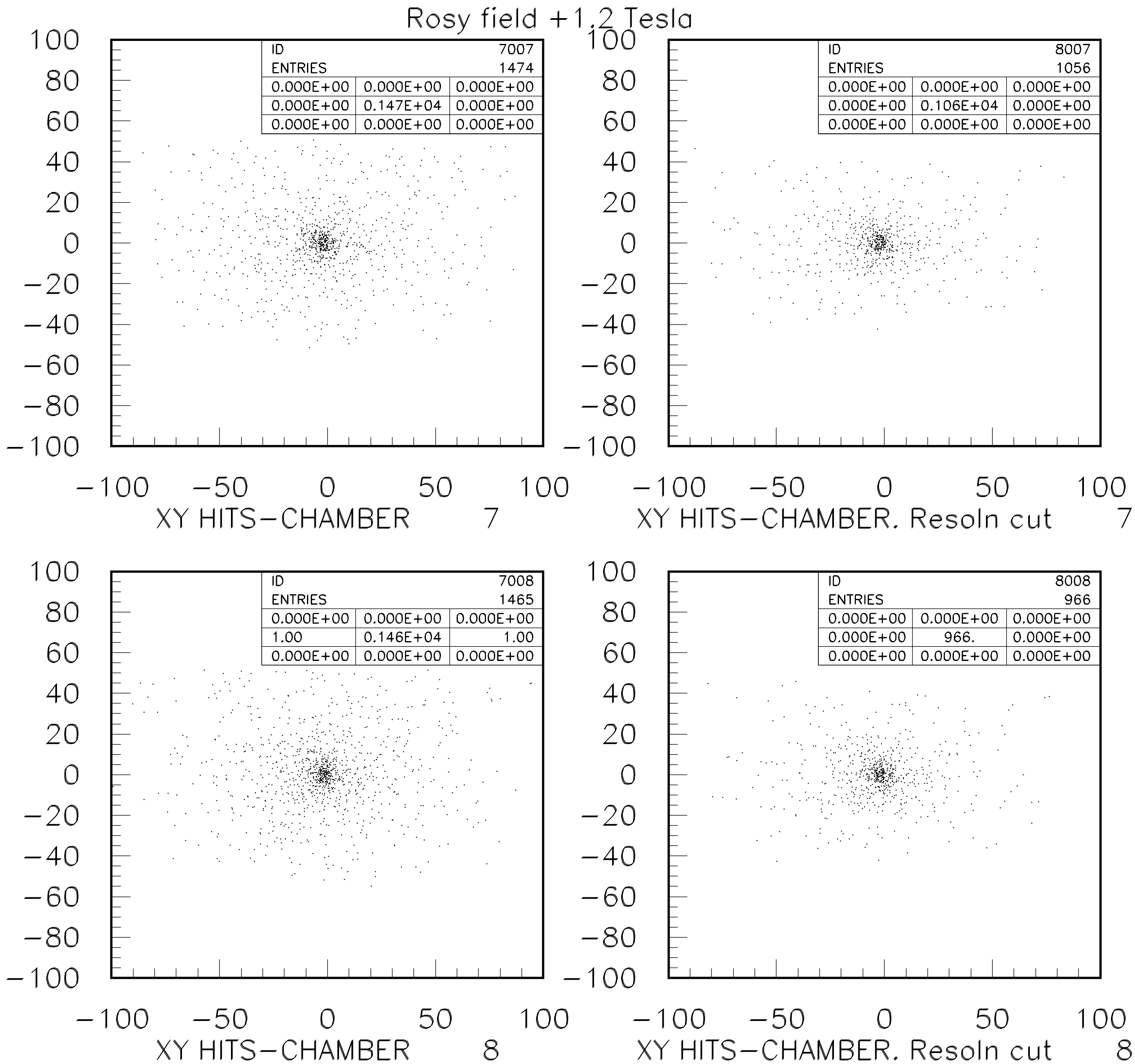



2001/09/03 17.11
Rosy field +1.2 Tesla
ID 7003
ENTRIES 2242
0.000E+00 8.00 0.000E+00
6.00 0.222E+04 4.00
0.000E+00 2.00 0.000E+00
XY HITS−CHAMBER 3
ID 8003
ENTRIES 2040
0.000E+00 2.00 0.000E+00
1.00 0.204E+04 0.000E+00
0.000E+00 1.00 0.000E+00
XY HITS−CHAMBER. Resoln cut 3
ID 7004
ENTRIES 2156
0.000E+00 5.00 0.000E+00
2.00 0.214E+04 4.00
0.000E+00 9.00 0.000E+00
XY HITS−CHAMBER 4
ID 8004
ENTRIES 1375
0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.138E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
XY HITS−CHAMBER. Resoln cut 4

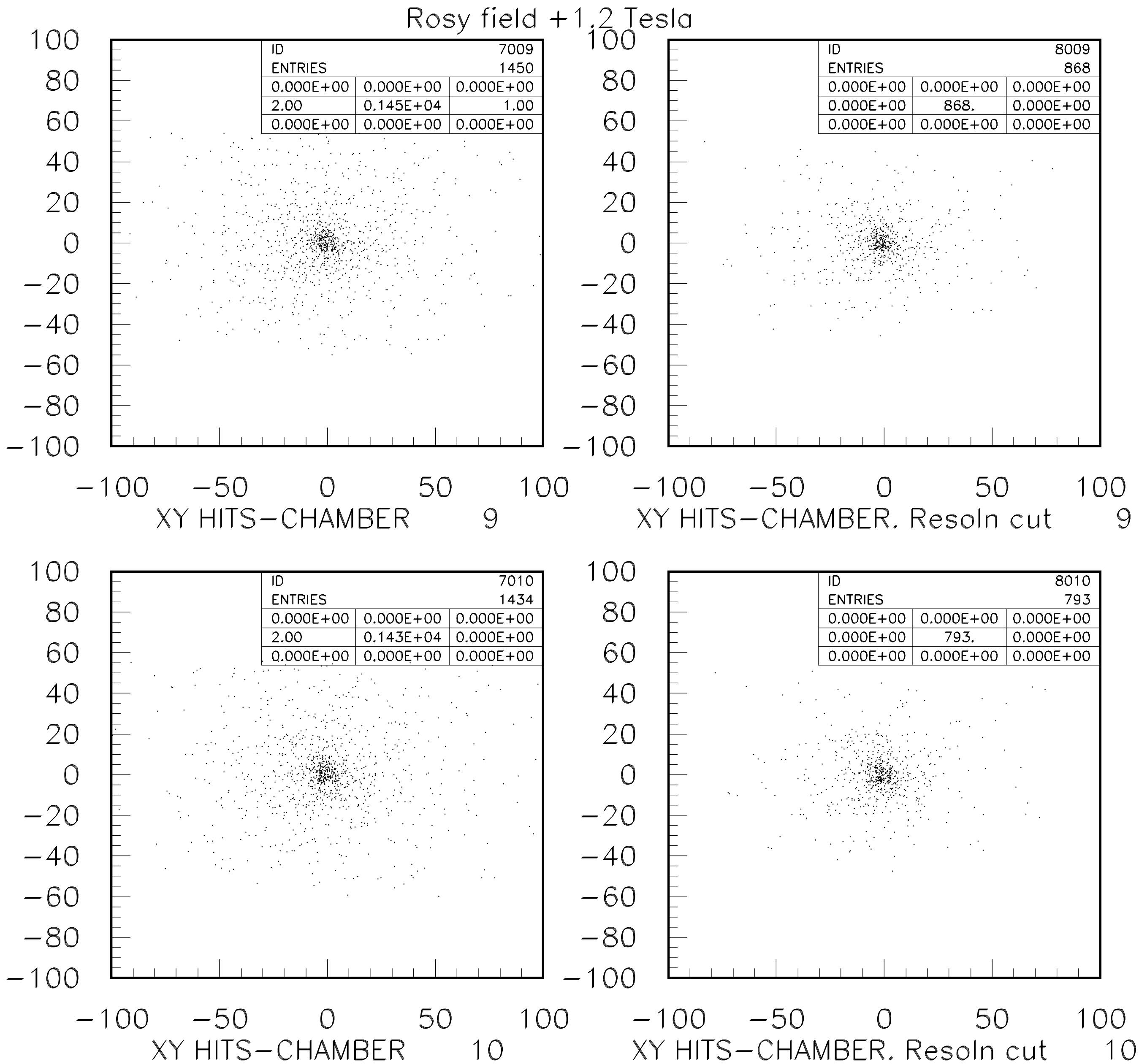
2001/09/03 17.11



2001/09/03 17.11

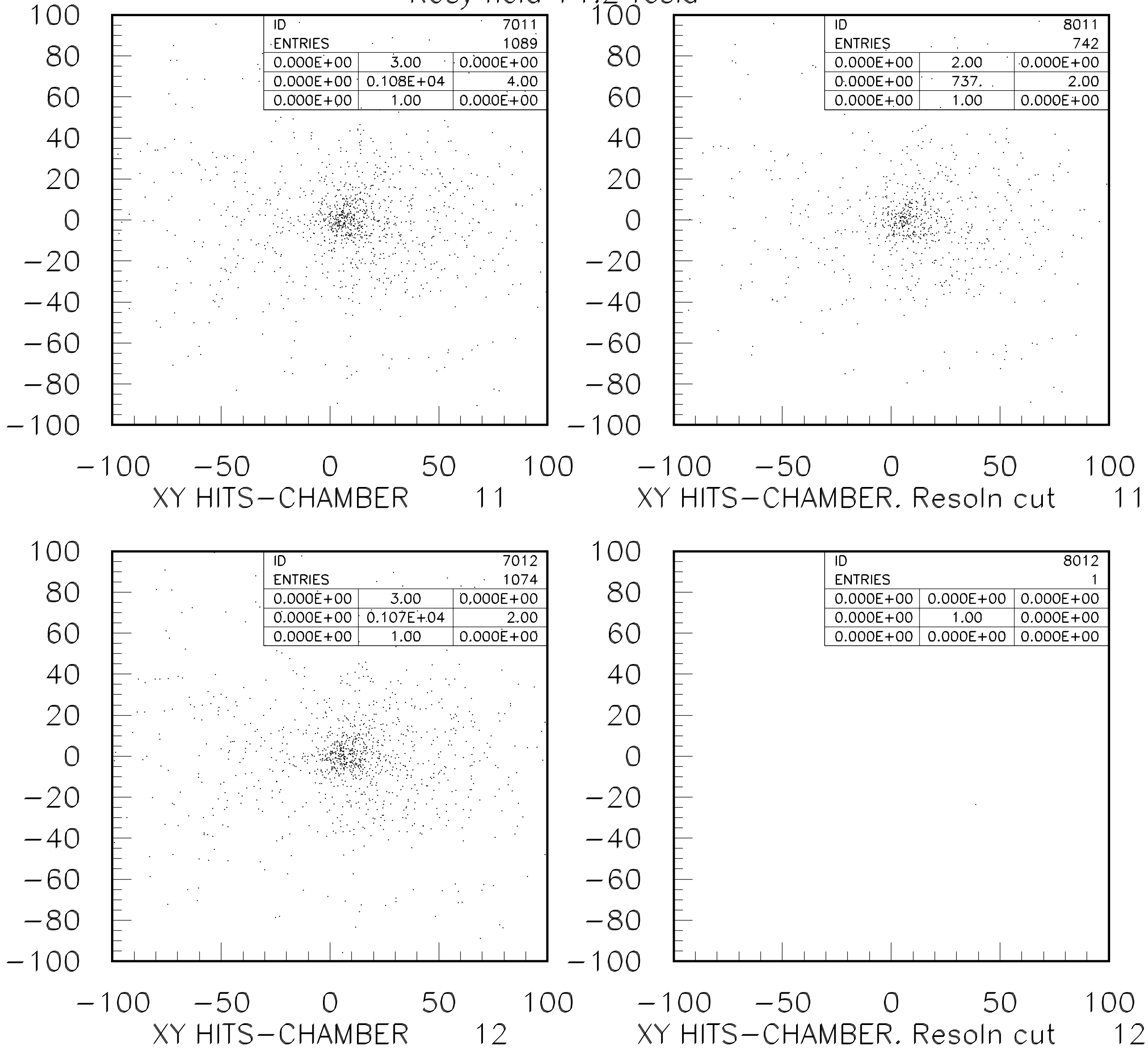


2001/09/03 17.11



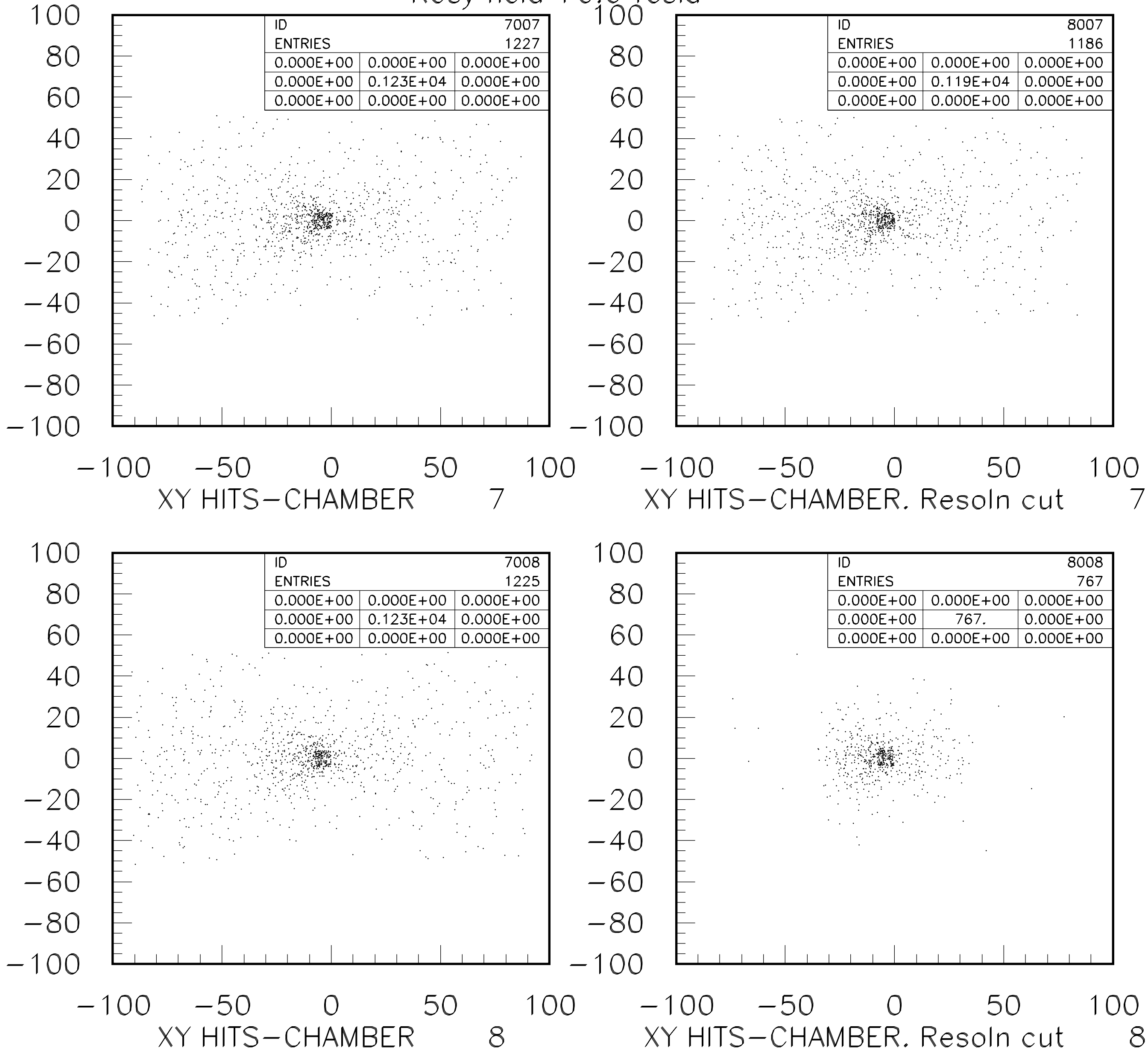
2001/09/03 17.11

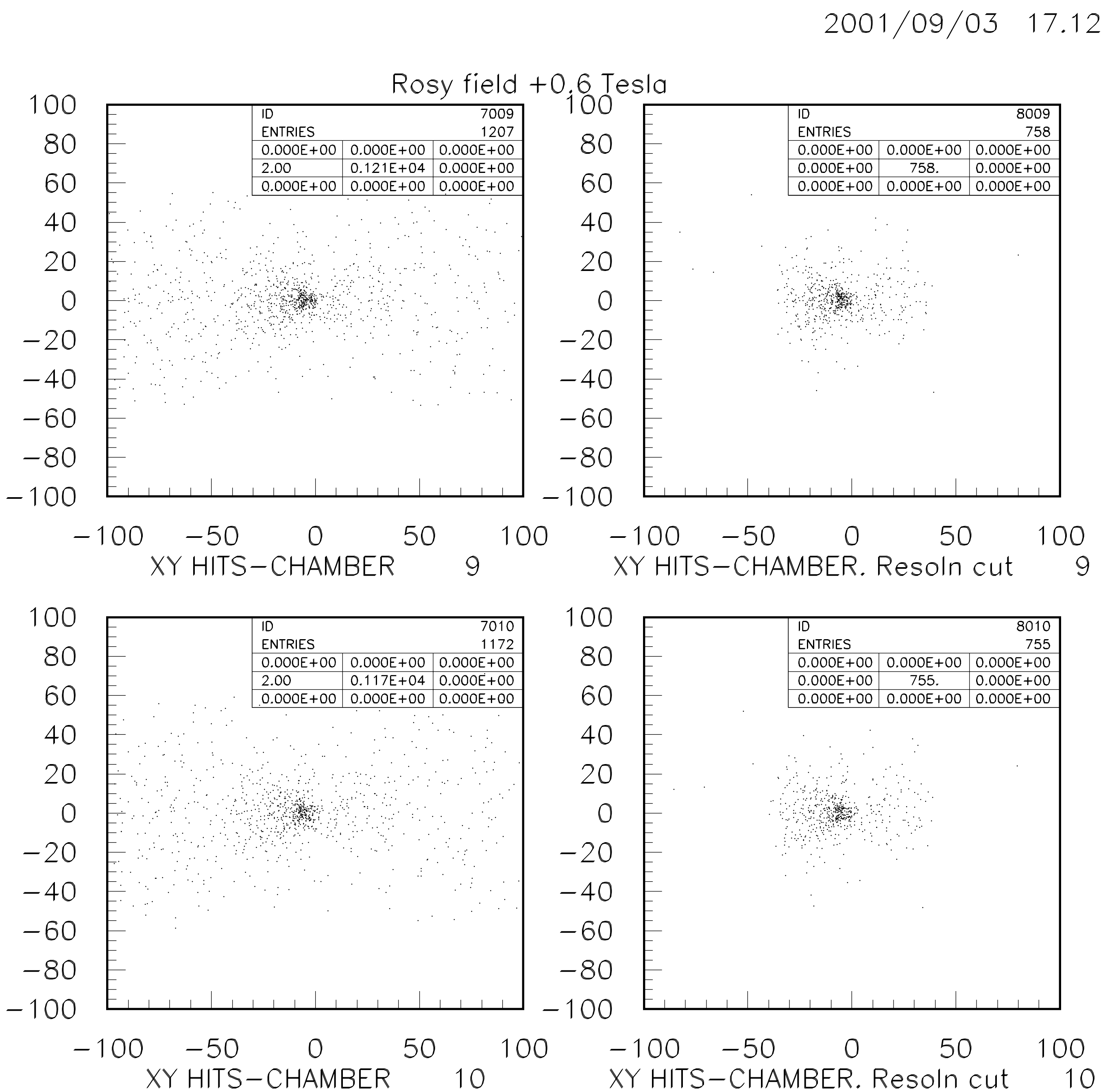
Rosy field +1.2 Tesla



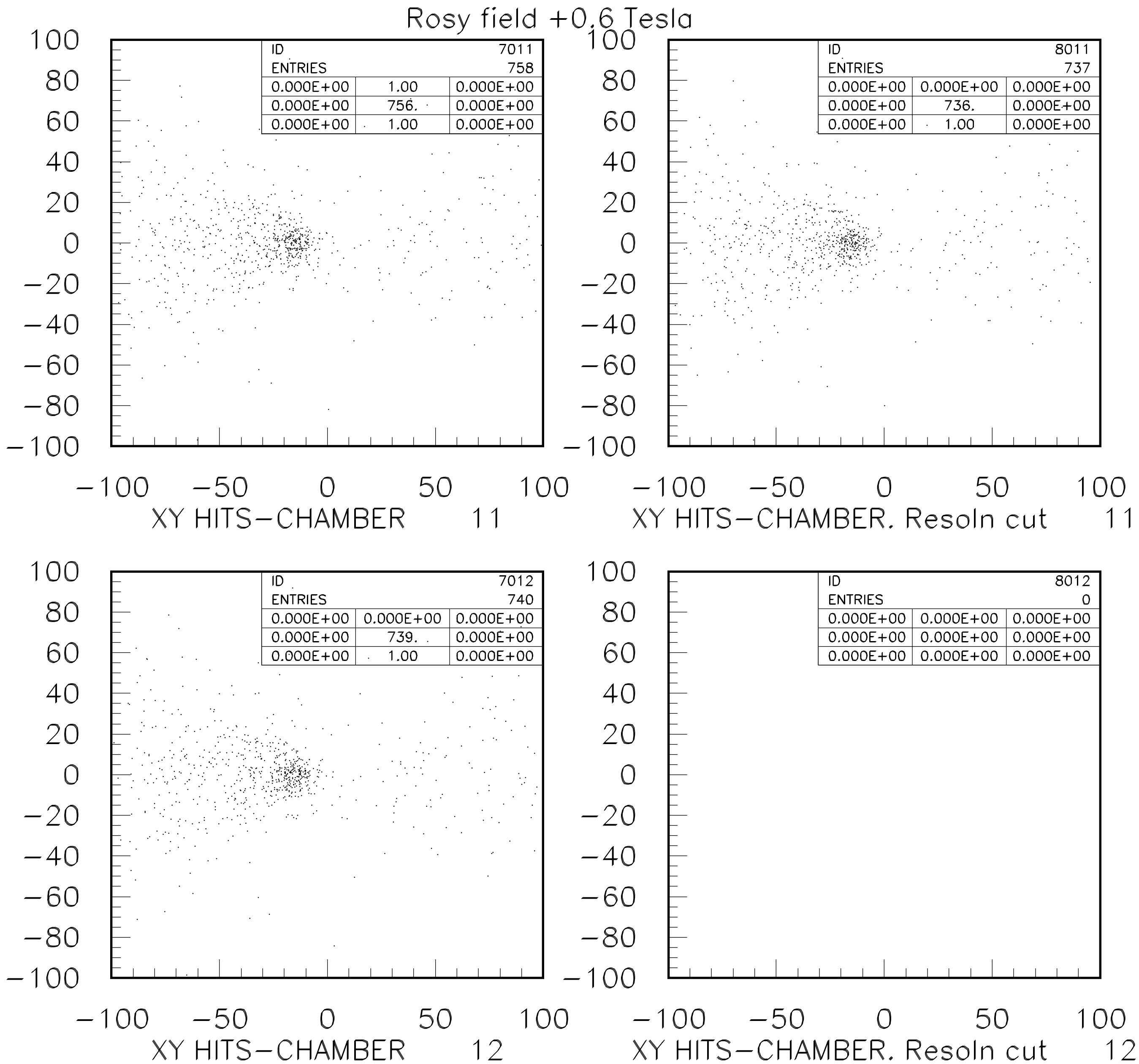
2001/09/03 17.12

Rosy field +0.6 Tesla



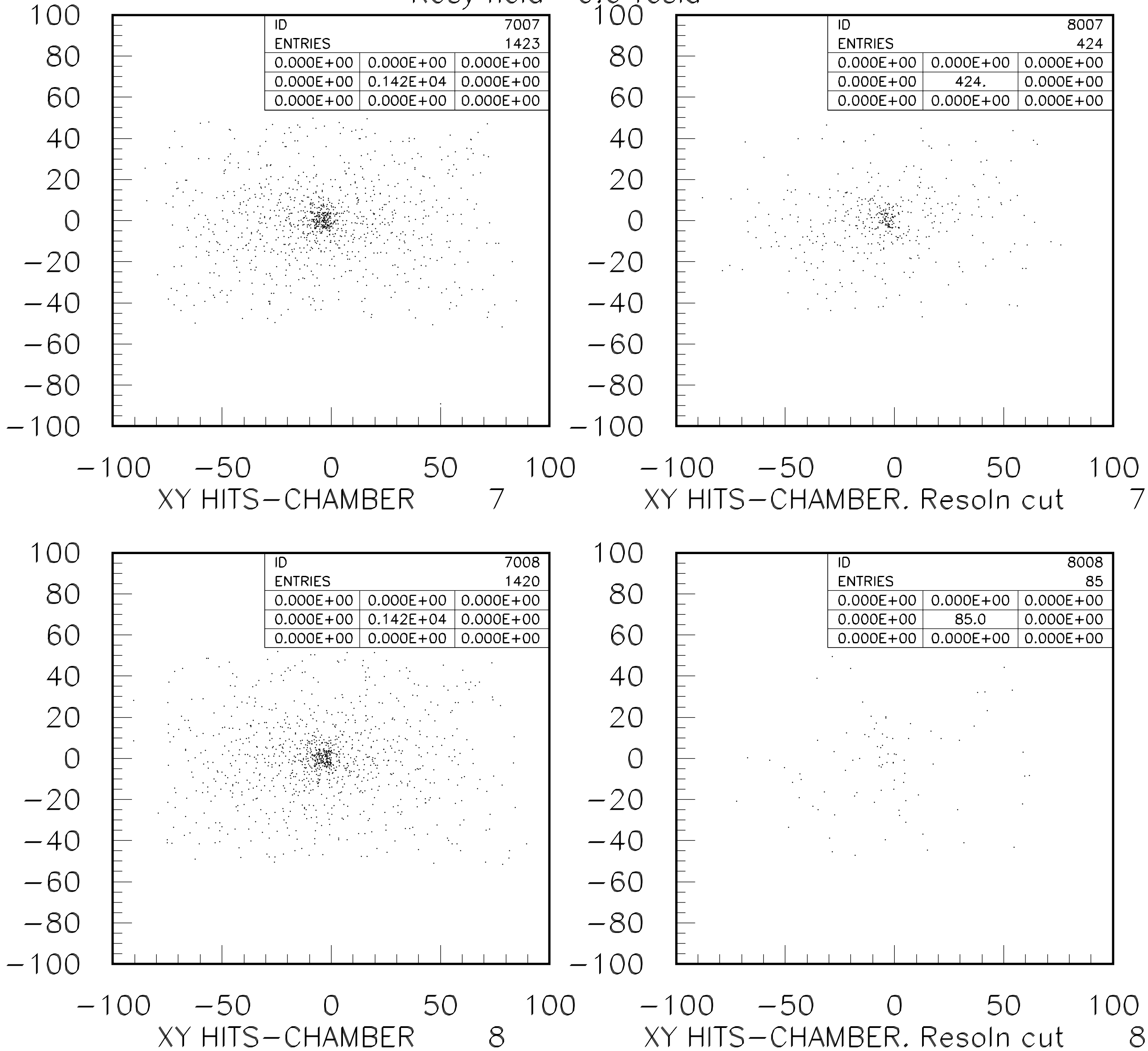

2001/09/03 17.12
Rosy field +0.6 Tesla
ID 7009
ENTRIES 1207
0.000E+00 0.000E+00 0.000E+00
2.00 0.121E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
XY HITS−CHAMBER 9
ID 8009
ENTRIES 758
0.000E+00 0.000E+00 0.000E+00
0.000E+00 758. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
XY HITS−CHAMBER. Resoln cut 9
ID 7010
ENTRIES 1172
0.000E+00 0.000E+00 0.000E+00
2.00 0.117E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
XY HITS−CHAMBER 10
ID 8010
ENTRIES 755
0.000E+00 0.000E+00 0.000E+00
0.000E+00 755. 0.000E+00
0.000E+00 0.000E+00 0.000E+00
XY HITS−CHAMBER. Resoln cut 10
100
80
60
40
20
0
−20
−40
−60
−80
−100
−100 −50 0 50 100

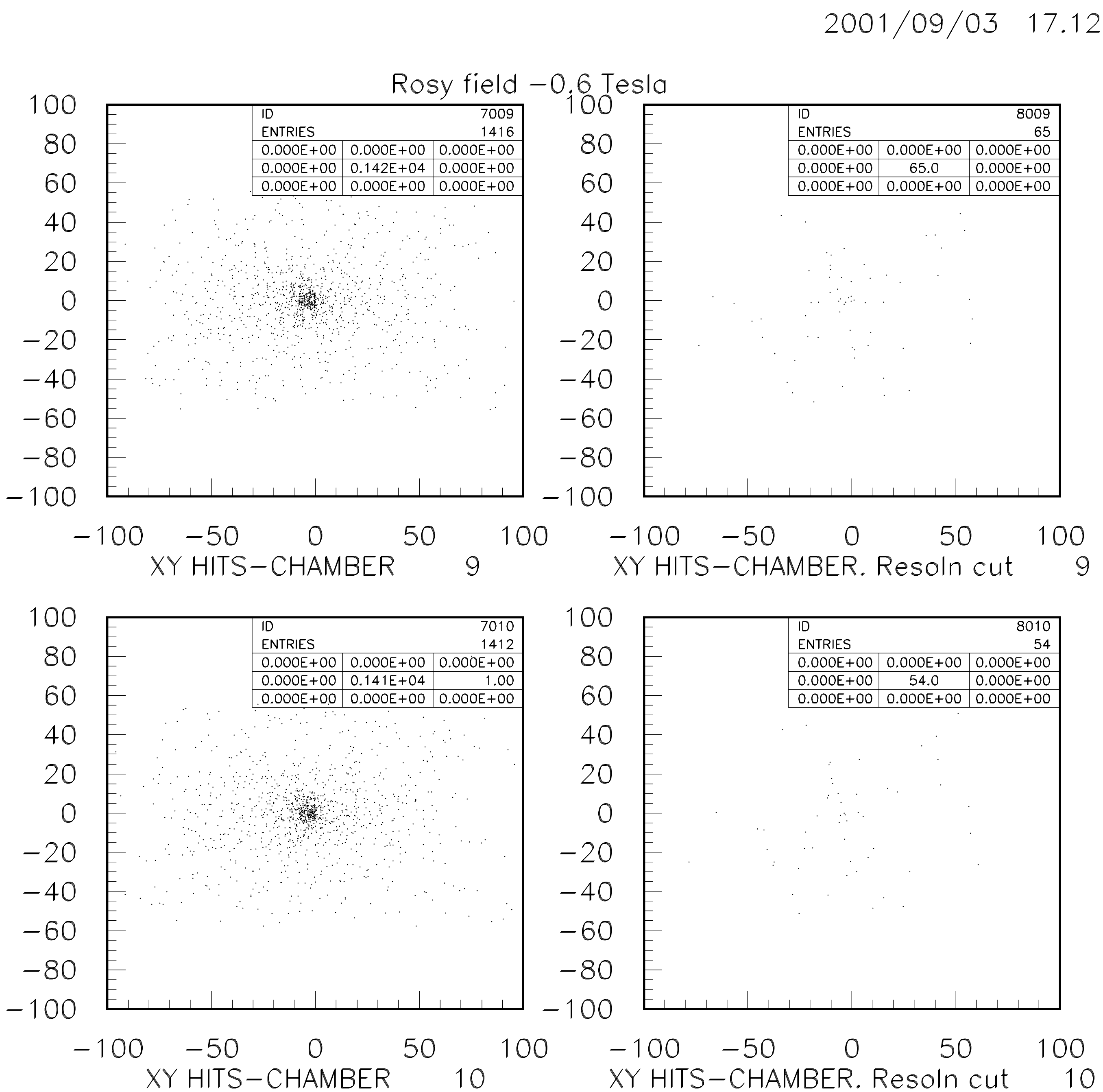
2001/09/03 17.12



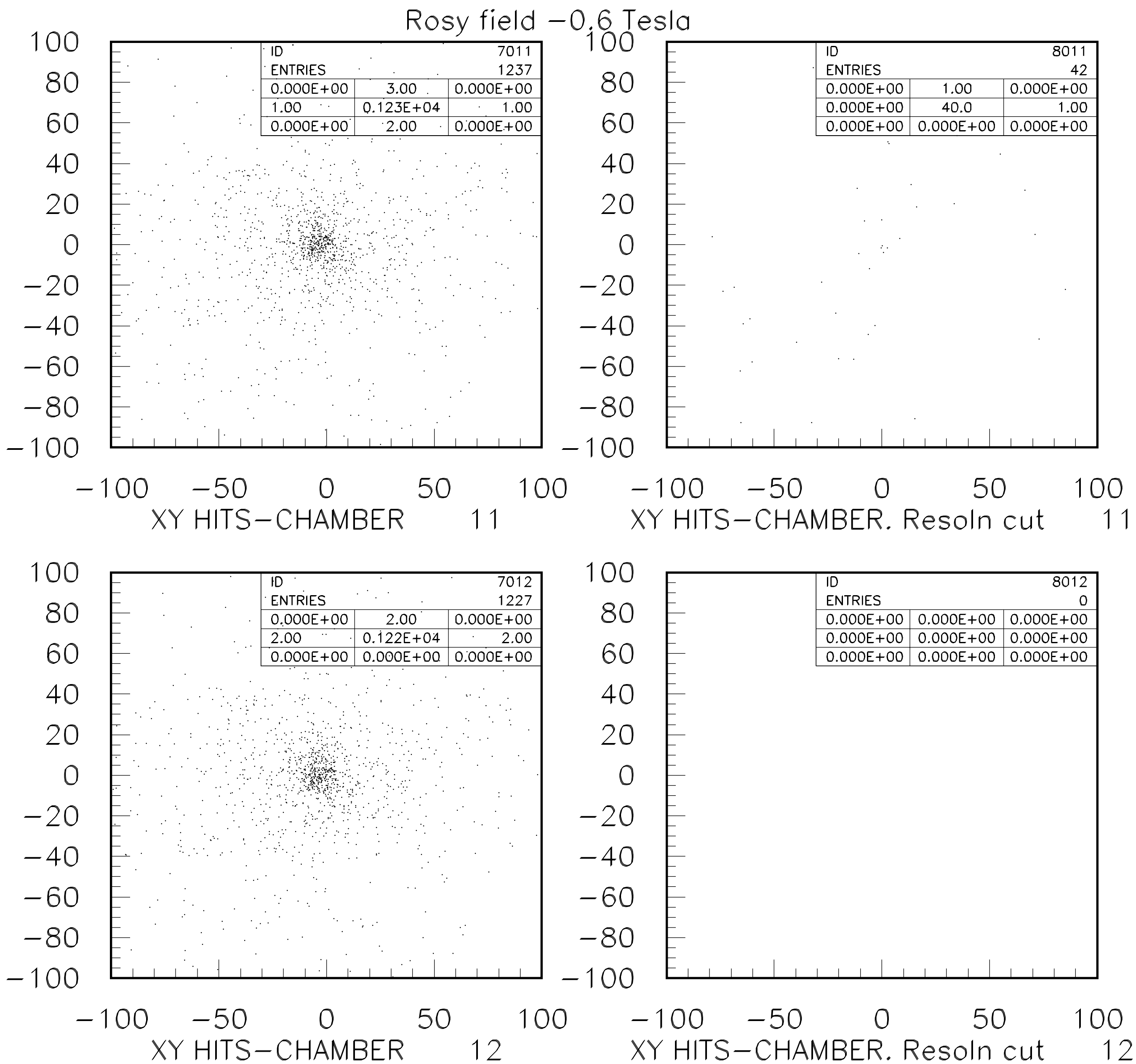
2001/09/03 17.12

Rosy field −0.6 Tesla

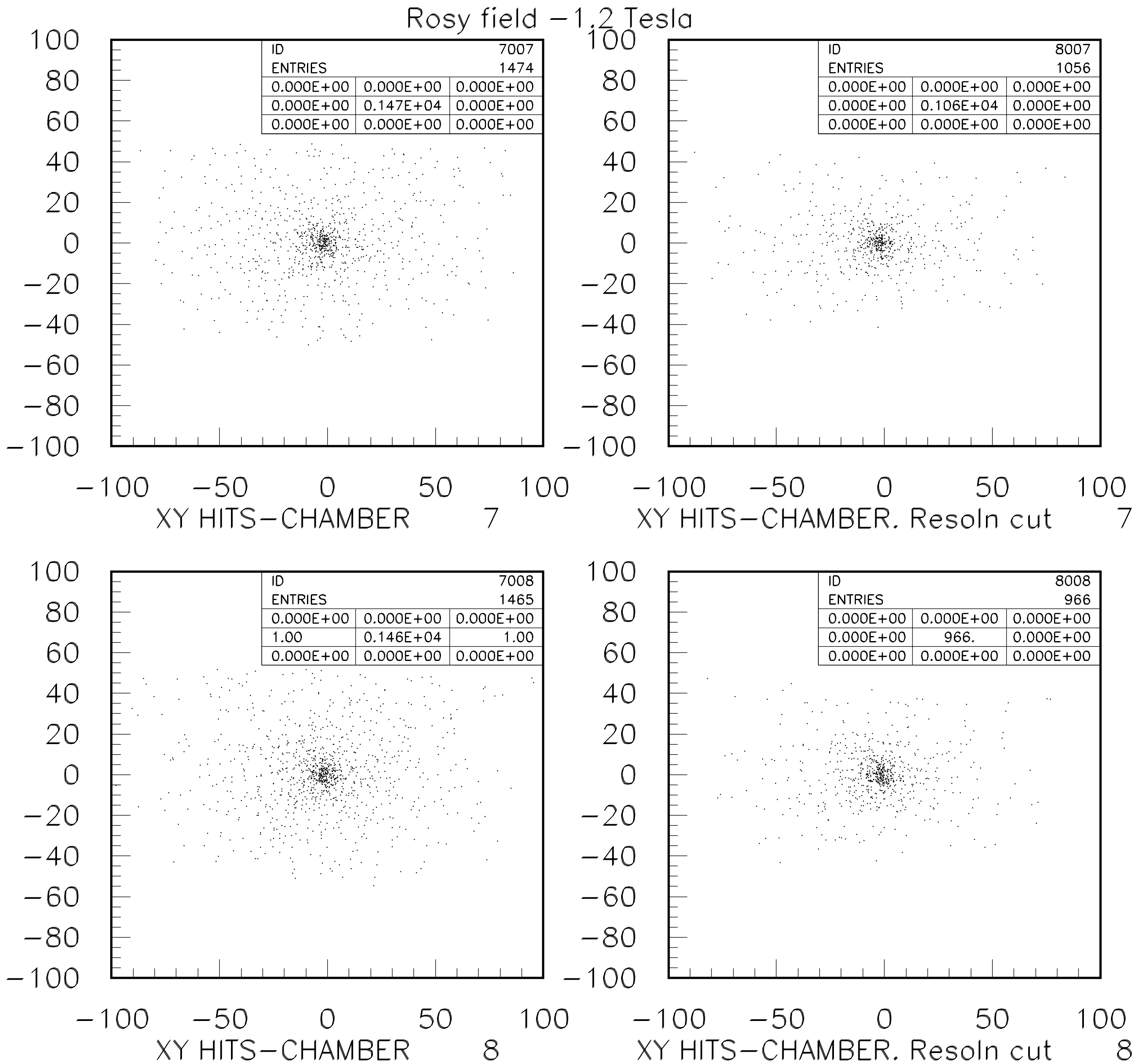



2001/09/03 17.12
Rosy field −0.6 Tesla
ID 7009
ENTRIES 1416
0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.142E+04 0.000E+00
0.000E+00 0.000E+00 0.000E+00
XY HITS−CHAMBER 9
ID 8009
ENTRIES 65
0.000E+00 0.000E+00 0.000E+00
0.000E+00 65.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
XY HITS−CHAMBER. Resoln cut 9
ID 7010
ENTRIES 1412
0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.141E+04 1.00
0.000E+00 0.000E+00 0.000E+00
XY HITS−CHAMBER 10
ID 8010
ENTRIES 54
0.000E+00 0.000E+00 0.000E+00
0.000E+00 54.0 0.000E+00
0.000E+00 0.000E+00 0.000E+00
XY HITS−CHAMBER. Resoln cut 10

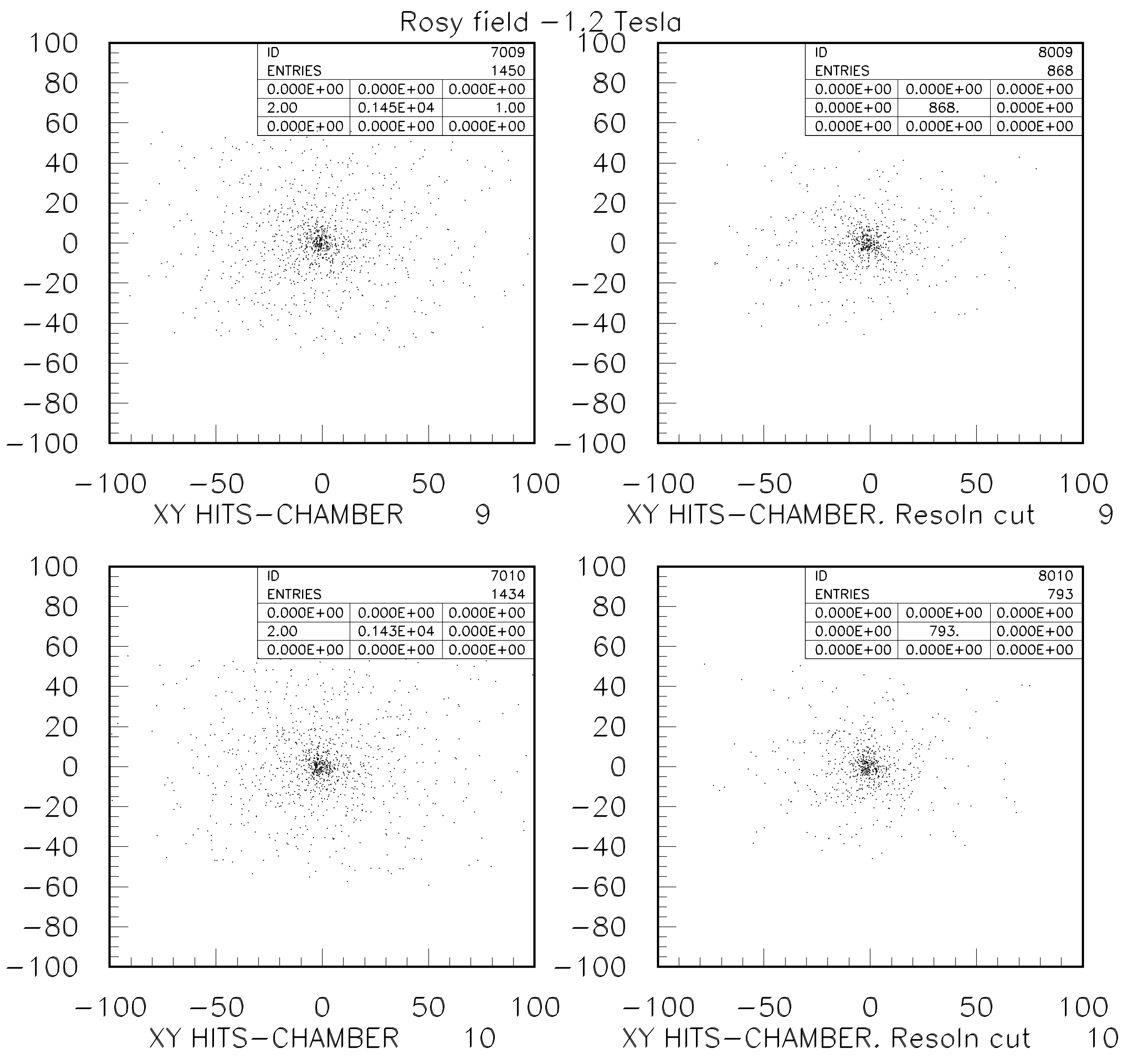
2001/09/03 17.12



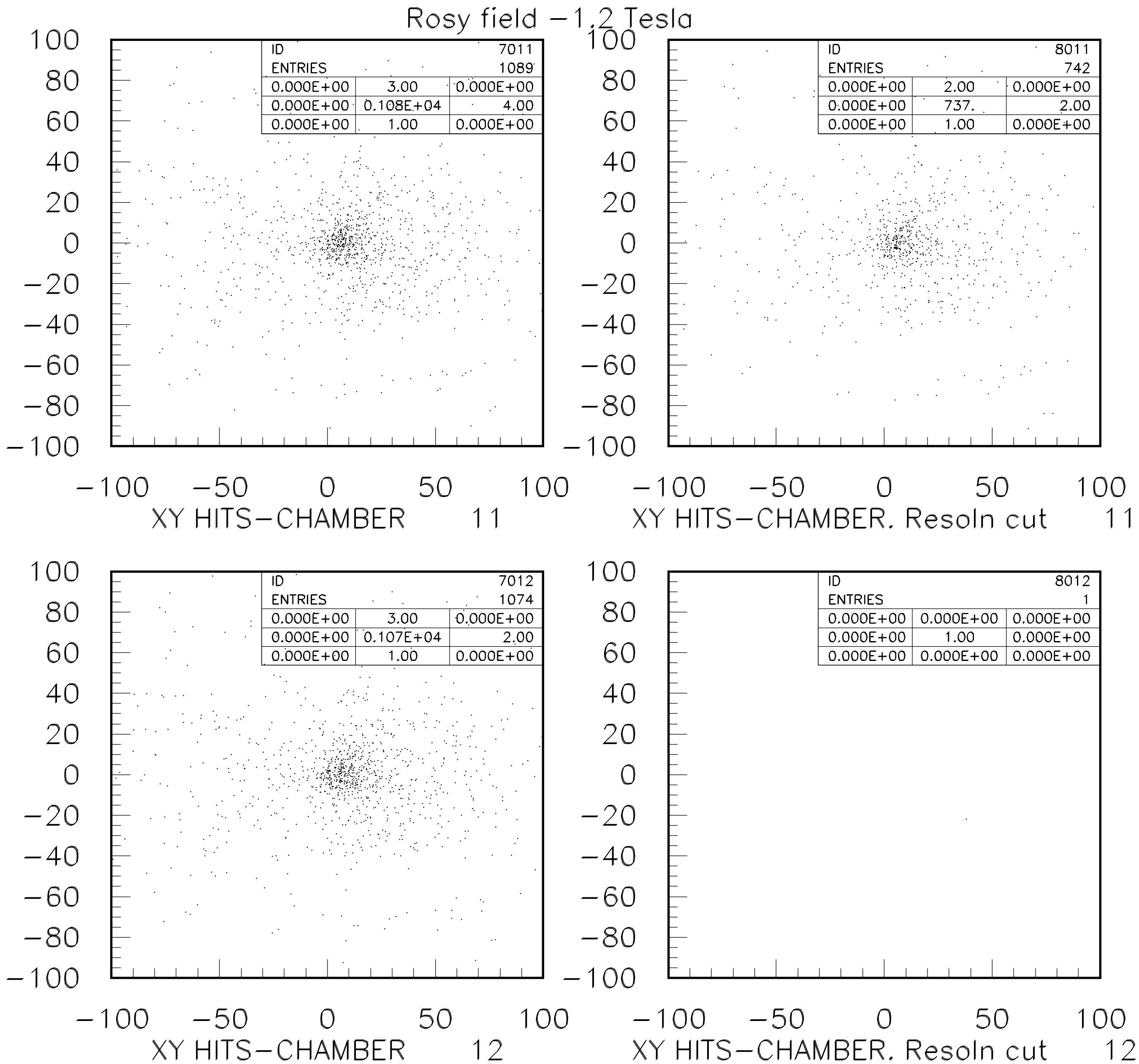
2001/09/03 17.12



2001/09/03 17.12



2001/09/03 17.12



Fermilab Chamber Spread Sheet

experiment	chamber type	chamber name	x-aperture (cm)	y-aperture (cm)	anode spacing (mm)	anode-to-cathode spacing (mm)	#planes	#wires	plane orientation	angles (to local vertical)
E687 (Focus)	PWC	Type I (P0, P3)	76.2	127	2.032	5.969	4	2296	x-y-u-v	0,90,101.3,-88.7
		P4'	101.6	152.4			3	1372	x-u-v	0,101.3,-88.7
		Type II (P1,P2,P4)	152.4	228.6	3.048	6.096	4	2944	x-y-u-v	0,90,101.3,-88.7
E690	MWC	Chamber 1	76.2	45.72	1.984375	3.2512	4	1536	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Chamber 2	91.44	60.96	1.984375	3.2512	4	1920	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Chamber 3	152.4	101.6	3.175	3.2512	4	1920	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Chamber 4	152.4	101.6	3.175	3.2512	4	1920	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Chamber 5	152.4	101.6	3.175	3.2512	4	1920	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Chamber 6	182.88	121.92	3.4925	3.2512	4	2048	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Beam Chamber 1-	15.24	10.16	1.016	1.397	4	640	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
		Beam Chamber 7-	38.1	20.32	1.524	1.397	4	1024	s-t-u-v	-21.7,-7.93,+7.93,+21.6'
E871(Selex)	MWC	m1_pwc_1	220	220	3				x-y-v-u	0,90,+28,-28
	DC	m1_dc1	200	150					x-x	0,0
	MWC	m1_pwc_2	220	220	3				x-y-v-u	0,90,+28,-28
	DC	m1_dc2	200	150					x-x	0,0
	MWC	m1_pwc_3	220	220	3				x-y-v-u	0,90,+28,-28
	MWC	m2_pwc_1	93	93	2				x-y	0,90
	MWC	m2_pwc_2	93	93	2				x-y	0,90
	MWC	m2_pwc_3	93	93	2				u-v	+28,-28
	MWC	m2_pwc_4	93	93	2				y-x	90,0
	MWC	m2_pwc_5	132	93	2				v-u	-28,+28
	MWC	m2_pwc_6	132	93	2				y-x	90,0
	MWC	m2_pwc_7	132	93	2				y-x	90,0
	MWC	m3_pwc_1	84.2	84.2					v-y-x-u	+28,90,0,-28
	MWC	m3_pwc_2	84.2	84.2					y-x	90,0
	MWC	m3_pwc_3	135	109.4					y-x-v	90,0,+28
HYPERCP	MWC	C1	45.72	25.4	1.0		4	1408	x-x'-u-v	
	MWC	C2	45.72	25.4	1.0		4	1408	x-x'-u-v	
	MWC	C3	55.88	30.48	1.25		4	1408	x-x'-u-v	
	MWC	C4	55.88	30.48	1.25		4	1408	x-x'-u-v	
	MWC	C5	152.4	40.64	1.5		4	3232	x-x'-u-v	
	MWC	C6	152.4	40.64	1.5		4	3232	x-x'-u-v	
	MWC	C7	203.2	55.88	2.0		4	4000	x-x'-u-v	
	MWC	C8	203.2	55.88	2.0		4	4000	x-x'-u-v	
	MWC	C9	203.2	55.88	2.0		4	4000	x-x'-u-v	